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SELECTED WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey
U.S. Department of the Interior

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W84-01401 -- W84-01769

The Secretary of the Interior has determined that the publication of the periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management ond Budget through September 30, 1985.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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THE WATER RESOURCES SCIENTIFIC INFORMATION CENTER DOES NOT PROVIDE COPIES OF DOCUMENTS ABSTRACTED IN THIS JOURNAL. Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey, MS 421
Reston, VA 22092

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05 WATER QUALITY MANAGEMENT AND PROTECTION

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SELECTED WATER RESOURCES ABSTRACTS

2. WATER CYCLE

2A. General

FACTORS AFFECTING THE ACCURACY OF QUANTITATIVE ANALYSES OF PRIORITY POLLUTANTS USING GC/MS,
Envirodyne Engineers, Inc., St. Louis, MO.
C. J. Kirchmer, M. C. Winter, and B. A. Kelly.
Environmental Science and Technology, Vol. 17, No. 7, p 396-401, July, 1983. 3 Fig, 4 Tab, 12 Ref.

Descriptors: *Pollutants, *Gas chromatography, *Mass spectrometry, Chemical analysis, Wastewater analysis, Calibrations.

Data obtained during the routine analyses of wastewaters by GC/MS using EPA Methods 624 and 625 were statistically evaluated to determine the principal sources of error in analysis. Random error was found to be the principal cause of inaccuracy in analyses using Method 624. Bias in calibration was found to be the principal source of error in analyses using Method 625. Average relative response factors were used to recalculate results for Method 624, and while the predicted improvement in accuracy was obtained in only one instance, further investigation is recommended. Results were also recalculated for Method 625 by using surrogate standards as internal standards to assure the calibration and sample analyses were done the same way. The alternative calibration procedure reduced calibration bias and random error in comparison with the standard Method 625 procedure. The advantages of using a calibration procedure identical with sample analyses are discussed. Suggestions are given for validating alternative methods prior to routine use. (Author's abstract)
W84-01507

THE ANNUAL PATTERN AND SPATIAL DISTRIBUTION OF AQUATIC OXYGEN METABOLISM IN BOREAL FOREST WATERSHEDS,
Woods Hole Oceanographic Institution, MA.
R. J. Naiman.
Ecological Monographs, Vol. 53, No. 1, p 73-94, 1983. 13 Fig, 10 Tab, 40 Ref.

Descriptors: *Oxygen metabolism, *Forest watersheds, *Aquatic ecosystems, Periphyton, Mosses, Macrophytes, Organic matter, Primary productivity, Metabolism, Streams, rivers, Lakes, Phytoplankton, Spatial distribution, Channel morphology, Quebec.

The level and diversity of metabolism in lotic ecosystems are largely functions of channel geomorphology and hydrology, making site-specific studies difficult to extrapolate to other parts of the watershed. This paper describes the pattern and distribution of aquatic oxygen metabolism for undistributed boreal forest watersheds in eastern Quebec, Canada. Metabolism by periphyton, mosses, macrophytes, fine particle organic matter (FPOM: 0.5 micrometer-1mm), and coarse particulate organic matter (CPOM: > 1mm) was examined during the ice-free period (April to November) of 1979 and 1980 in First Choice Creek (first order; 207 sq km), Matemek River (sixth order; 673 sq km), and the Moisie River (ninth order; 19,871 sq km). As watershed area increases, primary production and the number of autotrophic groups are augmented with moss and macrophyte communities. Total O2 metabolism increases downstream, ranging from < 1 g/sq m/d in First Choice Creek to nearly 5 g/sq m/d during summer in the Moisie river. Autotrophic metabolism is not normally correlated with light or chlorophyll, but annual O2 production is highly correlated with stream order (r(2) > .76 in most cases). These data are combined with a geomorphological analysis of the watershed to discern the spatial distribution of aquatic metabolism, and to estimate total aquatic metabolism in the Moisie River drainage network. Mosses, occurring only in streams of fourth or higher order, are the most productive autotrophic component in the watershed (3.9 x 10 to the 10th power g/yr); by comparison, periphyton produce only 2.1 x 10 to the 10th power g/yr. FPOM is the most active detrital component (6.6 x 10 to the 10th power g/yr). Geomorphic analyses show that streams of fourth or higher order compromise only 1.2% of the total number and 12.7% of the total length, but have 76.8% of the lotic surface area, and are responsible for 86.3% of the gross production by the entire lotic drainage network. The surface area of lakes is approximately six times that of streams, but their contribution (phytoplankton) to total aquatic ecosystems metabolism is comparable only to that of lotic periphyton. Results demonstrate that the River Continuum Concept can be extended to the watershed level by combining biological measurements with geomorphological analyses of the drainage network, thus allowing a detailed description of spatial and temporal patterns for specific metabolic components and total ecosystem metabolism to be constructed. (Author's abstract)
W84-01645

AN EPHEMERAL STREAM-AQUIFER INTERACTION MODEL,
Adelaide Univ. (Australia). Dept. of Civil Engineering.
P. J. Dillon, and J. A. Liggett.
Water Resources Research, Vol. 19, No. 3 p 621-626, June, 1983. 13 Fig, 13 Ref. NSF grant CEE-7902803.

Descriptors: *Ephemeral streams, *Aquifers, *Hydraulic models, Streambeds, Groundwater movement, Water level fluctuations, Mathematical models, Green-Ampt equation, Boundary conditions, Boundary integral equation, Stream discharge, Australia, Little Para River.

The boundary integral equation method is applied to the interaction between an ephemeral stream and an unconfined aquifer through a semipervious streambed. The resulting two-dimensional vertical slice model describes groundwater flow when the stream and aquifer are hydraulically disconnected or connected as well as the transition between these two states. It incorporates the Green-Ampt equation with the hydraulically disconnected boundary conditions. The model was successfully calibrated using stream discharge and bore hydrograph data from the Little Para River recharge study, South Australia. It predicts with sufficient accuracy the inflow and outflow from the stream to the aquifer during fluctuating water levels in the stream. (Author's abstract)
W84-01704

DYNAMIC ADVECTIVE WATER QUALITY MODEL FOR RIVERS,
Ohio State Univ., Columbus. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W84-01767

2B. Precipitation

HIMALAYAN WINTER SNOW COVER AREA AND SUMMER MONSOON RAINFALL OVER INDIA,
Howard Univ., Washington, DC. Dept. of Geology and Geography.
B. Dey, and O. S. R. U. Bhandu Kumar.
Journal of Geophysical Research, Vol. 88, No. C9, p 5471-5474, June 20, 1983. 3 Fig, 2 Tab, 22 Ref.

Descriptors: *Snow cover, *Monsoons, *Rainfall, Satellite imagery, Correlation analysis, Himalayas, India.

The study presented in this paper examines the relationship between satellite-derived Himalayan snow cover extent in the winter season (December to March) and the amount of summer monsoon rainfall for the period 1971 to 1980. Himalayan snow cover area has been derived from satellite images and northern hemisphere snow cover charts produced by the National Oceanic and Atmospheric Administration National Environmental Satellite Service. Indian summer monsoon rainfall was the area-weighted mean of all meteorological subdivisions of India for the months June through September. The variations of Indian summer monsoon rainfall were compared with the variation of the Himalayan winter snow cover area. There is an inverse relationship (negative correlation) between these two variables, which indicated that more than mean Himalayan winter snow cover area is to be followed by less than normal (India Meteorological Department (IMD)) summer monsoon rainfall over India. The inverse relationships hold true for 8 out of 10 years of the study period. The coefficients of the correlation between the Himalayan snow cover area departures from the 10-year mean and the rainfall departures from IMD normals for all the meteorological subdivisions of India were computed. The negative correlations were found to be maximum in the region between 18 degrees N latitude and the foothills of the Himalayas. (Author's abstract)
W84-01490

2C. Snow, Ice, and Frost

ICE BREAKUP AND JAMMING OBSERVATIONS ALONG THE MACKENZIE RIVER,
Queen's Univ., Kingston (Ontario). Dept. of Civil Engineering.
J. W. Kamphuis, and J. R. Moir.
Canadian Journal of Civil Engineering, Vol. 10, No. 1, p. 78-91, March, 1983. 14 Fig, 1 Tab, 2 Ref.

Descriptors: *Ice breakup, Ice jams, Melting, Mackenzie River, Canada.

The breakup of ice along the Mackenzie River between Fort Simpson and Fort Good Hope was studied in 1979, 1980, 1981, and 1982. This paper describes the 1980 and 1981 observations. An aircraft dedicated to this task was used to make over 40 observation flights during those two breakup seasons in which more than 20 major ice jams were observed during their formation, stationary position, and breakup. Although the paper is based on experience gained during only 4 years, it was found that all observed jams displayed the same major characteristics; hence it appears that general descriptions of ice melting, breakup, and jamming for the section of the Mackenzie River under investigation are possible. Although there could be additional variations, these are expected to be minor. The paper describes the ice melting process prior to any ice movement. The ice jamming process as it takes place along the Mackenzie River is discussed as well as the various parameters that affect this process. Several secondary factors that influence the detailed character of the jams are also addressed. (Author's abstract)
W84-01509

2D. Evaporation and Transpiration

ESTIMATION OF STREAMFLOW LOSS BY EVAPOTRANSPIRATION FROM A RIPARIAN ZONE,
Vrije Univ., Amsterdam (Netherlands). Inst. of Earth Sciences.
E. Seyhan, A. S. Hope, and R. E. Schulze.
South African Journal of Science, Vol. 19, No. 3, p 88-90, March, 1983. 2 Fig, 3 Tab, 10 Ref.

Descriptors: *Riparian water loss, *Evapotranspiration, Streamflow, Factor analysis, Correlation analysis, Regression analysis, Diurnal variation, Recession hydrograph, South Africa.

Recession hydrographs from a small research catchment in Zululand (South Africa) exhibited diurnal fluctuations in streamflow which were superimposed on the general recession trend. The daily additional reduction in flow was assumed to be the result of greater evapotranspirational losses in the riparian zone during the day. This reduction in flow was calculated for 76 days and an attempt was made to relate these values to hydrometeorological variables which could be expected to correlate with evapotranspirational losses. Factor analysis, correlation analysis and regression analysis were used to develop equations to estimate the daily additional reduction in streamflow. These equations were found to be satifactory with hydro-

graph stage being the most important independent variable. (Author's abstract)
W84-01443

EVAPOTRANSPIRATION OF EICHHORNIA CRASSIPES (MART.) SOLMS AND LEMNA MINOR L. IN CENTRAL FLORIDA: RELATION TO CANOPY STRUCTURE AND SEASON,
Florida Univ., Gainesville.
T. A. DeBusk, J. H. Ryther, and L. D. Williams.
Aquatic Botany, Vol. 16, No. 1, p 31-39, May, 1983. 5 Fig, 1 Tab, 12 Ref.

Descriptors: *Water hyacinth, *Evapotranspiration, Canopy, Seasonal variation, Temperature, Solar radiation, Duckweed, Evaporation, Water loss.

A major concern regarding water hyacinth (Eichhornia crassipes) infestations is the increased loss of water through evapotranspiration. However literature estimates of the evapotranspiration to open water evaporation ratio for Eichhornia may vary widely, from 1.4 to 3.7. Evapotranspiration of the freshwater macrophytes E. crassipes and Lemna minor was examined in tank cultures in Ft. Pierce, Florida. L. minor is a plant which grows essentially in two dimensions with little canopy variation. Evapotranspiration of both species during the year 1979 was significantly correlated with open water evaporation, solar radiation and mean temperature. Evapotranspiration of Eichhornia fluctuated by ca. 40% when its canopy structure was varied by manipulating plant stocking density or nutrient availability. Similar variations in canopy structure which commonly occur in natural stands of Eichhornia limit the value of evapotranspiration estimates made over a wide temporal or areal basis. Eichhornia is a floating plant adapted to riverine systems where expansions or reductions in habitat frequently occur, so the species rapidly responds to changing environmental parameters by varying its canopy structure and standing crop. (Moore-IVI)
W84-01453

EFFECT OF TRANSIENT, PARTIAL-AREA SHADING ON EVAPORATION FROM A BARE SOIL,
Kyushu Univ., Fukuoka (Japan). Irrigation Engineering Lab.
Y. Nakano, T. Cho, and D. Hillel.
Soil Science, Vol. 135, No. 5, p 282-295, May, 1983. 11 Fig, 11 Ref.

Descriptors: *Evaporation, *Soil surface, *Shade, Mathematical models, Simulation, Canopy, Water transport, Energy, Soil temperature, Soil water.

To evaluate the consumptive use efficiency of irrigated water, it is of interest to estimate the soil surface evaporation component of what is generally described by the term evapotranspiration. Interception of radiation by foliage is one of the major factors influencing evaporation. A three-dimensional mechanistic model describing soil-atmosphere energy exchange and water transport was developed in an effort to account for the effect of time-varying and space-variable shading on evaporation from a bare soil. A simple model of an inert (nontranspiring) plant was used to demonstrate the effect of shading on evaporation from the soil surface. The plant was represented hypothetically as an opaque, nonreflective sphere with the properties of a black-body emitter. During the course of a day, the effect of a canopylike shading body was to create a west-to-east shaded band in which soil surface temperature and evaporation were reduced (in comparison with a continuously sunlit surface) and soil moisture was enhanced. (Moore-IVI)
W84-01600

REPETITIVE-LOAD BEHAVIOR OF UNSATURATED SOILS,
E. S. Motan, and T. B. Edil.
Transportation Research Record, Vol. 872, p 41-48, 1982. 17 Fig, 1 Tab, 17 Ref.

Descriptors: *Soil mechanics, *Soil saturation, *Soil water suction, Sand, Clay, Plasticity, Matrix suction, Soil water, Soil compaction.

The resilient and residual deformation behavior of a number of soil samples under unconfined repetitive loading was investigated in the unsaturated state as a function of matrix suction. Matrix suction values within the range of 50-1500 kPa were achieved by using pressure-plate extractors. Results obtained during the first phase of the study on low-plasticity sand and clay mixtures are extended to high-plasticity clay during the second phase after a series of repetitive-load tests on statically compacted samples of grundite at both dry- and wet-of-optimum compaction moisture content. The resilient modulus is shown to be related to the matrix suction in a rather unique form for all soils tested; the maximum is at 800 kPa suction and it decreases thereafter and subsequently increases again significantly at very high suction values (as in the air-dried or oven-dried state). This maximum resilient modulus obtained at 800-kPa suction increases with decreasing plasticity index. The position and the form of the curve of resilient modulus versus matrix suction may undergo changes if deviator stress and confining pressure are introduced as variables. It is also shown that the resilient behavior of cohesive soils does not follow the same pattern as the relationship of unconfined strength versus suction beyond a suction value of 800 kPa. Furthermore, the postrepetetive testing unconfined strength of dry- and wet-of-optimum compacted samples seems to be better correlated with the moisture content than with the soil suction value. (Author's abstract)
W84-01755

2E. Streamflow and Runoff

FLOW TRANSFORMATIONS IN SEDIMENT GRAVITY FLOWS,
California Univ., Santa Barbara. Dept. of Geological Sciences.
R. V. Fisher.
Geology, Vol. 11, No. 5, p 273-274, May, 1983. 1 Fig, 26 Ref.

*Flow characteristics, *Gravity flow, *Sediment transport, Flow measurement, Streamflow, Runoff, Turbulent flow, Laminar flow.

Sediment gravity flows (subaerial or subaqueous) exhibit flow transformations, defined as changes in flow behavior between laminar and turbulent states. Laminar-turbulent transformations are influenced chiefly by particle concentration, thickness of the flow, and flow velocity (slope). At least four kinds of flow transformations can be identified: body transformations, gravity transformations, surface transformations, and fluidization transformations. Slumps or debris flows may change to turbidity currents with no change in water content when velocity is great enough to produce internal turbulence. The way that particles are supported within a flow in its final stages of movement largely determines the textures and structures within a bed. The manner of support is a direct function of particle concentration and amount of fine-grained cohesive sediment mixed with pore fluid, which in turn greatly affects whether or not laminar to turbulent or turbulent to laminar transformations take place. The concept of flow transformations is qualitatively useful in visualizing flow dynamics leading to the sequential development of beds within single depositional units. (Baker-IVI)
W84-01445

REGIONALIZED FLOW DURATION FOR PHILIPPINES,
Pittsburgh Univ., PA. Dept. of Civil Engineering.
R. G. Quimpo, A. A. Alejandrino, and T. A. McNally.
Journal of Water Resources Planning and Management, Vol. 109, No. 4, p 320-330, October, 1983. 5 Fig, 2 Tab, 8 Ref. INT7907044.

Descriptors: *Available water, *Flow duration, Mapping, Regression analysis, Small hydropower sites, Phillipines.

A regionalization technique is employed to obtain estimates of water availability at ungaged potential small hydropower sites in the Philippines. The flow duration characteristics at representative locations across the country were first parameterized to permit numerical interpolation. Then the geographic variation of one of the parameters was mapped to span the whole archipelago. Using regression, another parameter was expressed as a function of the drainage area. The regionalized map and the regression equation may then be used to synthesize a flow duration curve at an ungaged site. Future modifications of the procedure are suggested as additional data become available. (Author's abstract)
W84-01468

EFFECTS OF SOIL PROPERTIES ON OVERLAND FLOW AND INFILTRATION,
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
B. C. Yen, and A. O. Akan.
Journal of Hydraulic Research, Vol. 21, No. 2, p 153-172, 1983. 21 Fig, 1 Tab, 21 Ref.

Descriptors: *Overland flow, *Soil properties, Mathematical models, Simulation, Soil porosity, Permeability coefficient, Saturated flow, Unsaturated flow, Soil water suction, Infiltration, Particle size.

Soil properties have profound effects on overland flows over porous media. These effects are investigated by using a surface-subsurface flow conjunctive simulation model which solves the Saint-Venant equations for the overland flow and Richards' equation for the two-dimensional unsaturated and saturated porous medium flow. Guided by a dimensional analysis, four soil properties are studied, namely, porosity, vertical and horizontal saturated hydraulic conductivities, and unsaturated soil hydraulic characteristics which are expressed in two pairs of parameters describing the relationships between the degree of saturation and suction pressure, and between the relative conductivity and suction pressure, respectively. The results confirm the common belief that overland flow increases for decreasing soil porosity or saturated conductivity while the infiltration into the soil decreases. The effect of the ratio between horizontal and vertical saturated conductivity is insignificant, indicating the soil anisotropic effect is unimportant. Moreover, the overland flow decreases and infiltration increases for soils having small suction pressure head in the saturation and relative conductivity vs. suction pressure relationships, corresponding, to, e.g. increasing soil particle sizes, than for soils having large suction pressure head. (Author's abstract)
W84-01484

STOCHASTIC ANALYSIS OF HIGH FLOWS IN SOME CENTRAL BRITISH COLUMBIA RIVERS,
Saskatchewan Univ., Saskatoon. Dept. of Geography.
P. R. Waylen, and M.-K. Woo.
Canadian Journal of Civil Engineering, Vol. 10, No. 2, p 205-213, June, 1983. 7 Fig, 2 Tab, 14 Ref.

Descriptors: *High flow, *River flow, Probability distribution, Frequency distribution, Flow duration, Flow magnitude, Model studies, Stochastic studies, Floods, British Columbia.

High flows derived from the partial duration series were analysed in terms of the probability distributions of magnitude, frequency, durations, and the time of occurrence. Simple methods of representing the timing and duration of high flows as stochastic variables are presented. Existing stochastic models are applied to the probability distributions of the annual frequency of high flows and their magnitudes. A consideration of the statistical properties of the above stochastic variables leads to the development of a technique with which floods exceeding any higher level of interest may be investigated without resorting to a reanalysis of the historical data. The proposed methodology was applied to the daily streamflow records of three

rivers located in diverse hydrological environments in Central British Columbia. Good agreement between the computed and the observed data in all cases reflected the applicability of the technique. (Author's abstract)
W84-01511

URBAN HEADWATER FLOODING DAMAGE POTENTIAL,
Wiggins (J.H.) Co., Redondo Beach, CA.
L. T. Lee, and T. L. Essex.
Journal of Hydraulic Engineering, Vol. 109, No. 4, p 519-535, April, 1983. 2 Fig, 7 Tab, 12 Ref. ENV-76-24658.

Descriptors: *Headwater flooding, *Urban areas, Urban drainage, Flood damage, Flooding, Headwaters.

Headwater flooding, flooding from a small drainage area affecting only a few structures, has generally been ignored in estimating national flood losses. A field survey of 15 small, completely or partially urbanized watersheds encompassed about 50,000 structures and identified 241 structures subject to tributary flooding, 28 structures subject to intersection flooding, 100 subject to ponding, and 31 subject to constricted flow. A technique is developed for estimation the losses from headwater flooding, with an estimate of $324 million per year (1977) obtained. (Moore-IVI)
W84-01534

PRACTICAL METHOD OF ESTIMATING PEAK FLOW,
National Hydrology Research Inst., Ottawa (Ontario).
B. P. Sangal.
Journal of Hydraulic Engineering, Vol. 109, No. 4, p 549-563, April, 1983. 5 Fig, 10 Tab, 6 Ref.

Descriptors: *Flood peak, *Floods, Rainfall, Mathematical studies, Streamflow, Hydrographs, Ontario.

The variables used are the mean daily flows of three consecutive days with the maximum mean daily flow occupying the middle position. A parameter, designated as base factor K, has a governing influence on the estimated peak. Its value lies between zero and two. The predicting formula used in this study assumes the K value equal to one. The method was applied to streams in Ontario. A total of 387 stations equipped with recording gages were used. The drainage areas of the basins varied from less than 1 sq km to more than 100,000 sq km. The number of instantaneous peak data available was 3,946 in the period of record ending 1979. About 57% of the predicted peaks lie within + or - 10%, and 79% lie within + or - 20% of the actual values. About 62% of the peaks were overpredicted. The parameter K must be estimated for rainfall floods occurring on small streams. Its value will generally be less than one for such cases. As K represents the base of a triangular hydrograph, its value can be estimated from any method of a synthesizing graph. When peak data are available, values of K can be computed; these values may be transferred to nearby streams of similar physical characteristics. (Moore-IVI)
W84-01535

FITTING PROCEDURES FOR THE LOG-BOUGHTON DISTRIBUTION,
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
W. C. Boughton, and E. D. Shirley.
Journal of Hydraulic Engineering, Vol. 109, No. 4, p 579-589, April, 1983. 2 Fig, 4 Tab, 6 Ref.

Descriptors: *Annual floods, *Flood frequency, Computers, Walnut Gulch, Santa Cruz River, Arizona.

The original description of the log-Boughton distribution for frequency analyses of annual floods included trial-and-error procedures for fitting the distribution to a set of data. A procedure is described for direct, optimal fitting of the log-Boughton frequency distribution to either complete sets or subsets of annual flood data. The analytical basis and derivation of the procedure are given. Annual floods from 65 yr of record on the 5,755-sq km Santa Cruz River at Tucson, Arizona, are used to show the fitting of the distribution to a complete data set, and annual floods from 24 yr of record on the 149-sq km Walnut Gulch watershed, in southeastern Arizona, are used to show the fitting of the distribution to a subset of data. Substantial differences between the log-Boughton and log-Pearson type 3 distributions occur in fitting to the Walnut Gulch data, due mainly to the large negative skew coefficient (-2.83) of this data set. The computer program which fits the log-Boughton distribution plots the data points on a probability paper which is automatically scaled to linearize the fitted distribution. Records with years of zero flow can be fitted directly without making arbitrary adjustments. (Moore-IVI)
W84-01537

ANALYTICAL DETERMINATION OF FORM FRICTION FACTOR,
George Washington Univ., Washington, DC. Dept. of Civil, Mechanical, and Environmental Engineering.
M. I. Haque, and K. Mahmood.
Journal of Hydraulic Engineering, Vol. 109, No. 4, p 590-610, April, 1983. 12 Fig, 1 Tab, 25 Ref. INT 76-84262.

Descriptors: *Friction, *Bedforms, Ripple marks, Dunes, Hydraulic roughness, Alluvial hydraulics, Steepness, Stream discharge, Streambeds.

The form friction factors for an idealized series of two-dimensional bedforms simulating a train of ripples or dunes in alluvial channels are obtained analytically by integrating the pressure along the bedform profiles. The roughness element is assumed to act independently so that the form friction factor can be obtained by analyzing the flow over a single bedform. The pressure distribution along the bedform is obtained by analyzing the incompressible, rotational inviscid flow over a theoretical ripple profile with the help of the Finite Element Method. A family of curves representing the relationship between form friction factor and relative depth with different bedform steepness ratios are numerically obtained. The comparison with the observed data shows a fair agreement. (Author's abstract)
W84-01538

DEVELOPMENT AND PREDICTION OF BED ARMORING,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
H. W. Shen, and J. Y. Lu.
Journal of Hydraulic Engineering, Vol. 109, No. 4, p 611-629, April, 1983. 14 Fig, 5 Tab, 19 Ref. ENG-78250554.

Descriptors: *Bed armoring, *Particle size, Dam effects, Sediment transport, Turbulence, Hiding effect, Mathematical models.

After the construction of a dam, the clear water released from the reservoir usually causes the downstream river to degrade. One critical ingredient for the successful application of mathematical models to the degradation problem is how to predict change of bed material size distribution during the degradation process and the final composition of the armoring layer. Available data are used to predict the development of bed armoring and the final composition of grain size distribution. First, the different factors influencing the incipient motion for nonuniform sediment size distribution are examined. Then, the procedures for simulating the grain size distribution of the armor layer are developed based on modifications of Gessler's procedure and Einstein's hiding factor. The final armor coat can be simulated reasonably well based on Gessler's procedure if: the Shields curve is slightly modified; the hiding effect is introduced; and the turbulence level is considered. Three regression equations are derived to predict the median size of the final armor bed, given the initial sediment bed size distribution and flow conditions. A modified Shields diagram for incipient motion for nonuniform sediment sizes is also suggested. (Moore-IVI)
W84-01539

MODELING OF UNSTEADY-FLOW WATER TEMPERATURES,
Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
M. H. Chaudhry, D. E. Cass, and J. E. Edinger.
Journal of Hydraulic Engineering, Vol. 109, No. 5, p 657-669, May, 1983. 8 Fig, 17 Ref.

Descriptors: *Water temperature, *Mathematical models, Simulation, River Flow, Lakes, Unsteady flow, Diversion, Columbia River, Kootenay River.

A mathematical model is presented to simulate water temperatures of one-dimensional unsteady flows in a river-lake system having time-varying lateral inflows and several cross-sectional changes along its length. In the hydraulic part initial steady state conditions are computed by numerically integrating the gradually-varied flow equation using the fourth-order Runge-Kutta method and the unsteady flow conditions by integrating the one-dimensional Saint Venant equations using an implicit finite difference method. An upwind implicit finite difference scheme is used to solve the partial differential equation governing the water temperature of unsteady flows. To verify the mathematical model, water temperature data on the Columbia and Kootenay Rivers measured during 1977 through 1979 were used. Overall, there was good agreement between the measured and computed water temperatures at almost all locations. There was also very good agreement between the shapes of the computed and measured traces. The model was used to predict the effects of the Kootenay River diversion on the temperature regime of the Columbia River. (Moore-IVI)
W84-01540

APPLICABILITY OF DAM-BREAK FLOOD WAVE MODELS,
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W84-01543

TURBULENT FLOW OVER UNDULAR PERMEABLE BOUNDARIES,
Exxon Research and Engineering Co., Florham Park, NJ.
R. T. Ho, and L. W. Gelhar.
Journal of Hydraulic Engineering, Vol. 109, No. 5, p 741-756, May, 1983. 9 Fig, 1 Tab, 23 Ref. GK31774X.

Descriptors: *Turbulent flow, *Boundary permeability, Pipe flow, Undulation, Boundary pressure, Velocity, Wave form, Wavy pipes.

The interaction between turbulent flow and compliant confining boundaries often generates wavy interfaces which eventually modify the flow characteristics significantly. This is a common phenomenon in many natural flows, including: the formation of various bedforms in alluvial channels; the generation of water waves by wind; the growth of ripples on the underside of river ice; and the production of sand dunes in deserts. The effects of boundary permeability and undulation in turbulent pipe flow are observed in an air flow conduit lined with a granular permeable material. Boundary pressure, mean velocity distribution, and longitudinal turbulence intensity were measured at several sections along the sinusoidal boundary. The observed boundary pressure shows a phase shift relative to the boundary wave form and a magnitude similar to that found from a simple potential flow analysis. The mean velocity distributions differ drastically from those observed in impervious wavy pipes, implying an important effect of the aspiration from the porous boundary in the lee of the wave form. The observations of turbulence intensity show that boundary permeability dramatically alters the turbulence structure as compared to an impervious wavy pipe. In the permeable pipe, a zone of high intensity turbulence develops in the

lee of the boundary wave form and expands to the central portion of the pipe. For impervious wavy pipes, the high turbulence intensity occurs only near the boundary as in the case of a straight pipe. (Moore-IVI)
W84-01545

SUSPENDED SEDIMENT EFFECT ON FLOW RESISTANCE,
National Water Research Inst., Burlington (Ontario). Environmental Hydraulics Section.
Y. L. Lau.
Journal of Hydraulic Engineering, Vol. 109, No. 5, p 757-763, May, 1983. 4 Fig, 13 Ref.

Descriptors: *Suspended sediments, *Velocity, Flow resistance, Mathematical models, Wake function, Boundary conditions.

A general velocity distribution consisting of a logarithmic profile plus a wake function has been used to investigate the effect of suspended sediment on flow resistance. From the experimental evidence that the wake constant increases when sediment is in suspension, it is shown that flow resistance must be reduced. It is shown that a flow with suspended sediments should have lower velocities near the boundary and higher velocities further away from the boundary than a clear water flow, given that the discharge and slope are identical. (Author's abstract)
W84-01546

IMPROVED FLOODPLAIN MANAGEMENT CAN BE COST-EFFECTIVE,
J. A. Biggs.
American City and County, Vol. 98, No. 4, p 43-44, April, 1983. 1 Fig.

Descriptors: *Flood control, *Flood plain management, Photography, Aerial photography, Passaic River, River basins, New Jersey.

An estimated annual flood damage figure of $48 million makes the Passaic River Basin the more serious flood zone in New Jersey. The Rockaway River, a stream within the basin, drains 95 sq mi before entering Denville Township. In the township virtually the entire riverfront is subject to flooding. Documentation of the January 25, 1979 flood provided a data base for future floodplain management activities. Aerial and ground level photographs, along with a rough log that showed the times they were taken, formed the basic data for analyzing the floodplain within the township. The photo records were then transformed to engineering-type data through a land survey. After the study was completed it was used by the township in several ways: it formed the basis for a formal objection to the state Department of Environmental Protection concerning that agency's preliminary revision of the 1975 HUD/FIA map; it is used continuously by the engineering department to evaluate the flooding potential of existing and proposed houses; it is used to make decisions involving floodplain property; it has been a basic reference tool whenever the township considers such project as road construction and the construction of senior citizens' housing, municipal buildings, museums, libraries and other buildings; and photographs from the study have been introduced as evidence in municipal court to prove the floodplain status of properties where illegal fill has been placed. (Baker-IVI)
W84-01666

PARAMETER ESTIMATION IN RAINFALL-RUNOFF MODELS,
Newcastle Univ. (Australia).
B. J. Williams, and W. W-G. Yeh.
Journal of Hydrology, Vol. 63, No. 3-4, p 373-393, June, 1983. 8 Fig, 8 Tab, 27 Ref. NSF grant CEE 81-13500.

Descriptors: *Rainfall-runoff relationships, *Error analysis, Mathematical models, Linear programming, Quadratic programming, Computer models.

In the practical application of rainfall-runoff models a number of catchment parameters are not directly measurable and it is desirable to make the best possible estimate from known rainfall-runoff data. Linear programming (LP) is used to minimize the sum of absolute errors (MSAE) of the computed hydrograph. Quadratic programming (QP) is used in the two other techniques, namely ordinary least squares (OLS) and generalized least squares (GLS). OLS uses the traditional regression objective of minimizing the square of the deviation while GLS uses a weighted form of the OLS objective which can eliminate the effect of serially correlated errors (noise). The techniques are demonstrated using a hypothetical catchment for which rainfall-runoff series are generated using a connceptual model. Four parameters necessary for the model's operation are then estimated, with varying levels of noise superimposed on the generated series, using the three techniques and then finally the techniques are applied to a real catchment. The computational efficiency and rate of convergence were demonstrated to be good. The proposed methodology is very general and it can be applied to any conceptual rainfall-runoff model. The GLS technique has proven superior to the traditional OLS technique and would appear to be preferable in practical estimations. (Moore-IVI)
W84-01699

WAVE SPEED-DISCHARGE RELATIONS IN NATURAL CHANNELS,
Monash Univ., Clayton (Australia). Dept. of Civil Engineering.
T. H. F. Wong, and E. M. Laurenson.
Water Resources Research, Vol. 19, No. 3, p 701-706, June, 1983. 8 Fig, 2 Tab, 9 Ref.

Descriptors: *Flood waves, *Velocity, Flood discharge, Mathematical studies, Flood routing, Runoff routing, Murrumbidgee River, Darling River, Mitta Mitta River, Australia.

An important parameter in flood routing is the speed at which the flood wave travels along the river reach. Empirical studies of wave speed for six reaches of the Murrumbidgee, Darling and Mitta Mitta rivers in Australia show that wave speed at first increases quickly with discharge, then decreases quickly, and finally increases slowly. The increasing parts of the relation can be fitted by power functions with exponents less than unity. Minimum wave speed occurs close to bank-full discharge. These results have a direct application to storage-discharge relations and important implications in flood routing and runoff routing. (Moore-IVI)
W84-01712

SIMULATION OF SOLUTE TRANSPORT IN A MOUNTAIN POOL-AND-RIFFLE STREAM: A TRANSIENT STORAGE MODEL,
Geological Survey, Menlo Park, CA.
K. E. Bencala, and R. A. Walters.
Water Resources Research, Vol. 19, No. 3, p 718-724, June, 1983. 8 Fig, 1 Tab, 25 Ref.

Descriptors: *Mountain streams, *Solute transport, Streams, Simulation, Mathematical models, Transient storage, Pools, Riffles, Convection, Dispersion, Chloride.

The physical characteristics of mountain streams differ from the uniform and conceptually well-defined open channels for which the analysis of solute transport has been oriented in the past and is now well understood. These physical conditions significantly influence solute transport behavior, as demonstrated by a transient storage model simulation of solute transport in a very small (0.0125 cu m/s) mountain pool-and-riffle stream. The application is to a carefully controlled and intensively monitored chloride injection experiment. The data from the experiment are not explained by the standard convection-dispersion mechanisms alone. A transient storage model, which couples dead zones with the one-dimensional convection-dispersion equation, simulates the general characteristics of the solute transport behavior and a set of simulation parameters were determined that yield an adequate fit to the data. However, considerable uncertainty remains in determining physically realistic values of these parameters. The values of the simulation parameters used are compared to values used by other authors for other streams. The comparison supports, at least qualitatively, the determined parameter values. (Author's abstract)
W84-01714

A STOCHASTIC-DYNAMIC MODEL FOR REAL TIME FLOOD FORECASTING,
Queen's Univ., Kingston (Ontario).
K. C. A. Chow, W. E. Watt, and D. G. Watts.
Water Resources Research, Vol. 19, No. 3, p 746-752, June, 1983. 10 Fig, 3 Tab, 9 Ref.

Descriptors: *Flood forecasting, *Model studies, *Stochastic process, Water level, Headpond level, New Brunswick, Saint John river, Mactaquac Dam, Fredericton.

A stochastic-dynamic model for real time flood forecasting was developed using Box-Jenkins modelling techniques. The purpose of the forecasting system is to forecast flood levels of the Saint John River at Fredericton, New Brunswick. The model consists of two submodels: an upstream model used to forecast the headpond level at the Mactaquac Dam and a downstream model to forecast the water level at Fredericton. Inputs to the system are recorded values of the water level at East Florenceville, the headpond level and gate position at Mactaquac, and the water levels at Fredericton. The model was calibrated for the spring floods of 1973, 1974, 1977, and 1978, and its usefulness was verified for the 1979 flood. The forecasting results indicated that the stochastic-dynamic model produces reasonably accurate forecasts for lead times up to two days. These forecasts were then compared to those from the existing forecasting system and were found to be as reliable as those from the existing system. (Author's abstract)
W84-01718

RUNOFF PREDICTION ERRORS AND BIAS IN PARAMETER ESTIMATION INDUCED BY SPATIAL VARIABILITY OF PRECIPITATION,
Geological Survey, Menlo Park, CA.
B. M. Troutman.
Water Resources Research, Vol. 19, No. 3, p 791-810, June, 1983. 12 Fig, 13 Tab, 27 Ref.

Descriptors: *Rainfall-runoff relationships, *Error analysis, *Mathematical models, Precipitation, Stochastic methods, Spatial variability, Prediction, Rainfall distribution.

Spatial variability of precipitation causes inflated mean squared errors of prediction in precipitation-runoff modeling. One component of these larger errors is a bias, which often takes the form of overprediction for large events and underprediction for small events. This problem is examined using an assumed stochastic structure for the spatial behavior of rainfall together with a form of the Green-Ampt infiltration equation for prediction of storm runoff volume. The stochastic rainfall model incorporates the nonstationarity and spatial correlation exhibited by actual rainfall. The bias in runoff prediction causes parameter estimates obtained by least squares calibration to be asymptotically biased. The magnitude and direction of the bias depends on the interaction between the runoff prediction bias and the sensitivity of predicted runoff to changes in parameter values. Numerous climatic and hydrologic factors exercise an influence on this interaction. (Author's abstract)
W84-01722

BAYESIAN SURROGATE FOR REGIONAL SKEW IN FLOOD FREQUENCY ANALYSIS,
Monash Univ., Clayton (Australia). Dept. of Civil Engineering.
G. Kuczera.
Water Resources Research, Vol. 19, No. 3, p 821-832, June, 1983. 7 Fig, 9 Tab, 27 Ref.

Descriptors: *Flood data, *Flood frequency, *Temporal distribution, Design floods, Flood distribution, Frequency analysis.

The problem of how to best utilize site and regional flood data to infer the shape parameter of a flood distribution is considered. One approach to this problem is given in Bulletin 17B of the U.S. Water Resources Council (1981) for the log-Pearson distribution. Here a lesser known distribution is considered, namely, the power normal which fits flood data as well as the log-Pearson and has a shape parameter denoted by lambda derived from a Box-Cox power transformation. The problem of regionalizing lambda is considered from an empirical Bayes perspective where site and regional flood data are used to infer lambda. The distortive effects of spatial correlation and heterogeneity of site sampling variance of lambda are explicitly studied with spatial correlation being found to be of secondary importance. The end product of this analysis is the posterior distribution of the power normal parameters expressing, in probabilistic terms, what is known about the parameters given site flood data and regional information on lambda. This distribution can be used to provide the designer with several types of information. The posterior distribution of the T-year flood is derived. The effect of nonlinearity in lambda on inference is illustrated. Because uncertainty in lambda is explicitly allowed for, the understatement in confidence limits due to fixing lambda (analogous to fixing log skew) is avoided. Finally, it is shown how to obtain the marginal flood distribution which can be used to select a design flood with specified exceedance probability. (Author's abstract)
W84-01724

APPLICATION OF A BAYESIAN MODEL TO DETECT SHIFTS IN THE MEAN OF A SERIES (APPLICATION D'UN MODELE BAYESIEN DE DETECTION DE CHANGEMENTS DE MOYENNES DANS UNE SERIE),
Hydro-Quebec, Montreal. Service Hydraulique.
P. Bruneau, and J.-C. Rassam.
Hydrological Sciences Journal, Vol. 28, No. 3, p 341-354, September, 1983. 10 Fig, 5 Tab, 9 Ref.

Descriptors: *Mathematical models, *Flow, *Reservoir operation, Bayesian models, Climate, River flow, Means, Sainte-Anne du Nord River, Quebec.

A Bayesian model has been applied on the annual and monthly flow series of the Sainte-Anne du Nord River in order to check the influence of the operation of four reservoirs on the monthly series in terms of a shift delta in the mean at time Tau. The same model has been tested on two other series, thus permitting identification of those shifts that would be attributed to regionally observed climatic variations. (Author's abstract)
W84-01761

HYDROLOGICAL RESPONSE PATTERNS OF SOME THIRD ORDER STREAMS ON THE BASEMENT COMPLEX OF SOUTHWESTERN NIGERIA,
Ife Univ. (Nigeria). Dept. of Geography.
J. O. Adejuwon, L. K. Jeje, and O. O. Ogunkoya.
Hydrological Sciences Journal, Vol. 28, No. 3, p 377-389, September, 1983. 3 Fig, 3 Tab, 21 Ref.

Descriptors: *Seasonal variation, *Hydrological regime, *Flow discharge, Peak discharge, Rainy season, Dry season, River flow, Groundwater, Variability, Recession, Hydrological response, Rainfall, Regolith depth, Nigeria.

The hydrological response patterns of 15 third order rivers in southwestern Nigeria are described in terms of regime, discharge variability and recession of flow from peak discharge in the rainy season to the lowest discharge in the dry season. The maximum and minimum discharges of the rivers coincide with the rainy and dry seasons respectively. Most of the rivers exhibit erratic flow with quick responses to storms and storm water abating quickly, while some have a very low groundwater contribution to streamflow, a phenomenon which accounted for their drying up for considerable periods in the year. The variability indices of discharge of the rivers range from 0.25 to 2.12 while the recession constants range from 0.64 to 0.98. The variability indices are much higher than those of basins of similar size reported from other studies. Three types of rivers are recognizable on the basis of their hydrological response patterns: rivers characterized by perennial flow, low variability of discharge, and gentle recession of flow from peak discharge in the rainy season to minimum discharge in the dry season; rivers with high discharges during the rainy season but which dry up completely for between 100 and 150 days in the dry season; and seasonal rivers which dry up for between 190 and 270 days in the year. The nature of the surficial and solid geology has a greater influence on discharge characteristics than other factors such as depth of regolith and rainfall. (Moore-IVI)
W84-01763

ON BACKWATER EFFECTS IN LINEAR DIFFUSION FLOOD ROUTING,
University Coll., Dublin (Ireland). Dept. of Civil Engineering.
J. C. I. Dooge, Z. W. Kundzewicz, and J. J. Napiorkowski.
Hydrological Sciences Journal, Vol. 28, No. 3, p 391-402, September, 1983. 2 Tab, 10 Ref.

Descriptors: *Flood routing, *Linear diffusion, *Boundary conditions, *Downstream, Mathematical models, Laplace transformation, Modal analysis.

The linear parabolic model of unsteady river flow (diffusion analogy) has the advantage of being a simple means of flood routing. The effect of the downstream boundary condition on the flow in a channel reach as predicted by the linear diffusion analogy model is analyzed by both Laplace transformation and by modal analysis. In each case the solution takes the form of an infinite series. The series based on Laplace transformation is highly convergent for small times and the series based on modal analysis is highly convergent for medium and longer times. (Moore-IVI)
W84-01764

2F. Groundwater

AQUIFER TESTS AND WELL FIELD PERFORMANCE, SCIOTO RIVER VALLEY, OHIO: PART I,
S. E. Norris.
Ground Water, Vol. 21, No. 3, p 287-292, May-June, 1983. 2 Fig, 3 Tab, 11 Ref.

Descriptors: *Aquifer characteristics, *Infiltration, Transmissivity, Streambeds, Pumping, Drawdown, Scioto River, Ohio.

Based on 13 aquifer infiltration tests at 11 sites, aquifer transmissivity ranged from 17,000 to 40,000 sq ft per day, and the streambed infiltration rate ranged from 0.06 to 0.19 million gallons per day per acre along a 7-mi reach of the Scioto River in south-central Ohio. Despite these wide ranges, the sand and gravel aquifer, 40 to 65 ft thick, underlying 10-20 ft of river alluvium south of the glacial boundary, is fairly homogeneous due largely to the absence of till interbeds. Performance of a major well field designed on the basis of the tests has been about as predicted, validating the techniques of data collection and analysis. At each site, a well for pumping was drilled on the floodplain, 150 to 175 ft from the river, and an array of observation wells was installed on lines extending through the pumped well, one line perpendicular to the river and the other parallel. Values of drawdown measured in the observation wells at the end of constant-rate pumping periods, usually of three days duration, were used to determine line-source distance and aquifer transmissivity. The rate of streambed infiltration and the streambed-leakage factor, the latter term relating the infiltration rate to drawdown beneath the stream, also were determined at all but one site. Drive-point wells installed in the riverbed, or along the near bank, in the vicinity of the pumped well were used to determine drawdown beneath the river due to pumping. (Author's abstract)
W84-01548

GROUND-WATER MODEL FOR A THICK FRESH-WATER LENS,
Hawaii Univ. at Manoa, Honolulu. Dept. of Civil Engineering.
C. C. K. Liu, L. S. Lau, and J. F. Mink.
Ground Water, Vol. 21, No. 3, p 293-300, May-June, 1983. 10 Fig, 2 Tab, 12 Ref.

Descriptors: *Groundwater, *Freshwater lens, Aquifers, Groundwater movement, Simulation, Pumping, Pumping, Mathematical models, Groundwater recharge, Pearl Harbor aquifer, Oahu, Hawaii.

The Pearl Harbor aquifer, an important groundwater resource for southern Oahu, Hawaii, contains an enormous fresh-water lens, up to 300 m (1,000 ft) thick, floating above saline water. The upper boundary of the fresh-water lens is confined near the coast and phreatic inland, whereas its lower boundary is not confined. A finite-difference flow model was used to simulate the Pearl Harbor aquifer system. The location of the fresh-water / salt-water interface, which constitutes the lower boundary of the flow system model, was estimated by Hubbert's formula. Known geohydrologic boundaries and aquifer parameters were also simulated. First, formation of the lens by filling the aquifer with fresh water from natural recharge was simulated to reconstruct the initial conditions before exploitation of the lens and to partially calibrate the model against the hydraulic-head distribution in 1879. The model then was calibrated fully by simulating the lens' response to actual historical pumping patterns covering a time span of 100 years (1880 to 1980). Simulated heads compared favorably with the observed heads over time and space. The calibrated flow model may serve as a useful tool in the management of the Pearl Harbor aquifer. (Author's abstract)
W84-01549

GROUND-WATER SYSTEMS SIMULATION BY TIME-SERIES TECHNIQUES,
Aspinwall Hydrotechnical Services Ltd., Shrewsbury (England).
J. F. T. Houston.
Ground Water, Vol. 21, No. 3, p 301-310, May-June, 1983. 10 Fig, 6 Tab, 9 Ref.

Descriptors: *Simulation, *Groundwater, Time-series, Hydrologic budget, Pumping rates, Geohydrology, Mathematical models, Rainfall, Mine dewatering, Groundwater management, Water level fluctuations.

The application of time-series techniques to groundwater problems is a logical extension of the water balance approach, allowing a water balance equation to become dynamic and thus simulating a groundwater system in time. The basic time-series techniques are considered in relation to hydrogeology and two case histories show their application to real systems. Water level fluctuations in a well field are shown to be dependent upon pumping rates and prior rainfall and can be simulated by a multiple linear regression model. The rate of dewatering of a mine is shown to be dependent upon pumping rates and prior rainfall and can be simulated by a multiple linear regression model. The rate of dewatering of a mine is shown to be dependent upon antecedent mine size and rainfall, and can also be simulated by a multiple linear regression model. Such models can be used for forecasting and control of the groundwater systems, and once formulated are ideally suited to the management of groundwater systems where more costly and complex methods cannot be used. (Moore-IVI)
W84-01550

PORE-WATER PRESSURE IN THE ROOF OF AN UNDERGROUND COAL MINE IN ILLINOIS,
Illinois State Geological Survey Div., Champaign.
K. Cartwright, C. S. Hunt, R. D. Brower, and W. J. Nelson.
Ground Water, Vol. 21, No. 3, p 311-316, May-June, 1983. 4 Fig, 11 Ref.

Descriptors: *Pore pressure, *Mine drainage, Coal mines, Permeability coefficient, Groundwater, Geohydrology, Water table, Stratigraphy.

Most underground coal mines in Illinois are relatively dry despite their location in saturated rock lying hundreds of meters below the water table. This is probably due to the low permeabilities of the rock units associated with the coal seams. Little is known about how mines affect the groundwater system, so it is difficult to predict where a mine is likely to encounter an influx of ground water. To obtain information on the hydrogeological character of the roof rocks, an array of piezometers was installed in roof-bolt holes at two locations within an underground coal mine in central Illinois. Pressure vs. time measurements were obtained from piezometer arrays located in areas of the mine ranging from dry to wet conditions. Data collected from the piezometers indicate that water drainage from a saturated sandstone above the coal is largely controlled by local structural and stratigraphic features, and these features determine the distribution of wet and dry areas in the mine. Hydraulic conductivities of the sandstone were determined in the laboratory and in situ from drainage profiles and from tests of instantaneous head changes. Results of these tests indicated that dewatering in front of mining would not be successful in this mine. (Author's abstract)
W84-01551

HYDROGEOLOGY OF THE LITTLEFIELD SPRINGS, ARIZONA,
Bureau of Reclamation, Boulder City, NV.
D. A. Trudeau, J. W. Hess, and R. L. Jacobson.
Ground Water, Vol. 21, No. 3, p 325-333, May-June, 1983. 7 Fig, 3 Tab, 12 Ref.

Descriptors: *Groundwater recharge, *Geohydrology, *Springs, Tritium, Water quality, Littlefield Springs, Virgin River, Arizona.

A hydrogeologic investigation was conducted to determine the source of recharge to the Littlefield Springs, a series of carbonate springs occurring along a 10 km (6 mile) reach of the Virgin River in northwestern Arizona. The most probable sources of recharge to the springs were determined to be influent Virgin River water and precipitation within the springs by hydrologic basin. These recharge sources could account for the total discharge of the springs. The Littlefield Springs have essentially constant discharge 1.84 cms (65 cfs), and quality 2940 mg/L TDS. Tritium analyses of the spring and river water indicate that there are at least two different sources of recharge to the Littlefield Springs - one a minimum of 22 years old and the other younger than 22 years old. Analysis of the influent Virgin River upstream from the springs indicates a 1.42 cms (50 cfs) loss at 2130 mg/L TDS and the same ionic ratio of dissolved constituents as the springs. The travel time of this recharge source is interpreted to be a minimum of 22 years. Local recharge to the springs has been estimated to be 0.31 cms (11 cfs). The presence of local recharge is indicated by pulse train gaging of the springs, and by water quality at a well upstream of the springs and at the first upstream occurrence of the springs. The travel time of this recharge source is interpreted to be less than 22 years. (Author's abstract)
W84-01553

GEOPHYSICAL LOGGING IN CARBONATE AQUIFERS,
Geological Survey, Spokane, WA. Water Resources Div.
L. M. MacCary.
Ground Water, Vol. 21, No. 3, p 334-342, May-June, 1983. 15 Fig, 8 Ref.

Descriptors: *Logging (recording), *Aquifers, Well logs, Limestone, Dolomite, Porosity, Water quality, Resistivity, Groundwater recharge, Groundwater movement, Water temperature, Saline water.

Some logging methods are inherently superior to others for the analysis of limestone and dolomite aquifers. Three such systems are the density, neutron, and acoustic-velocity logs. Relative percentages of limestone and dolomite, average matrix (grain) densities of the rock mixtures, and porosity of the rock mass can be calculated from density, neutron, and acoustic-velocity logs. Wells drilled before the 1960's generally were logged with an uncalibrated neutron tool. In some instances, the resultant curve can be empirically calibrated. With supporting data from resistivity logs, apparent water resistivity (Rwa) can be estimated. Depending on rock and mud resistivities, the two most useful resistivity curves for water quality studies are the deeply-focused laterolog and the induction log. For older wells, the standard electric log may be used, if the drilling mud is not salt-saturated. Rwa contour maps derived from geophysical data are useful to outline areas of recharge, direction of probable groundwater flow, and location and salinity of brine areas. Another useful application of well logs is estimation of ground-water temperature. These temperatures are obtained from maximum-reading thermometer data that generally are recorded on each logging run. Maps of porosity can be used to outline potential areas for completing large-yield wells. (Author's abstract)
W84-01554

AQUEOUS GEOCHEMISTRY AND THE EXCHANGEABLE CATION COMPOSITION OF GLAUCONITE IN THE AQUIA AQUIFER, MARYLAND,
Geological Survey, Towson, MD.
For primary bibliographic entry see Field 2K.
W84-01555

MIGRATION OF CONTAMINANTS IN GROUNDWATER AT A LANDFILL: A CASE STUDY; 2. GROUNDWATER MONITORING DEVICES,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
For primary bibliographic entry see Field 5B.
W84-01685

MIGRATION OF CONTAMINANTS IN GROUNDWATER AT A LANDFILL: A CASE STUDY; 4. A NATURAL-GRADIENT DISPERSION TEST,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
For primary bibliographic entry see Field 5B.
W84-01687

MIGRATION OF CONTAMINANTS IN GROUNDWATER AT A LANDFILL: A CASE STUDY; 5. CATION MIGRATION IN THE DISPERSION TEST,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
For primary bibliographic entry see Field 5B.
W84-01688

MIGRATION OF CONTAMINANTS IN GROUNDWATER AT A LANDFILL: A CASE STUDY; 6. HYDROGEOCHEMISTRY,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
For primary bibliographic entry see Field 5B.
W84-01689

MIGRATION OF CONTAMINANTS IN GROUNDWATER AT A LANDFILL: A CASE STUDY; 7. DC, VLF, AND INDUCTIVE RESISTIVITY SURVEYS,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
For primary bibliographic entry see Field 5B.
W84-01690

GROUNDWATER RECHARGE THROUGH A HEAVY-TEXTURED SOIL,
Department of Agriculture, Lethbridge (Alberta). Irrigation Div.
M. J. Hendry.
Journal of Hydrology, Vol. 63, No. 3-4, p 201-209, June, 1983. 5 Fig, 11 Ref.

Descriptors: *Groundwater recharge, *Soil water, *Soil texture, Tritium, Tracers, Particle size, Fracture permeability, Fracture flow, Intergranular seepage, Alberta, Water table.

A testhole was cored to a depth of 17.4 m below ground surface in southern Alberta, Canada, and 55 samples were collected from the cores at 0.3-m intervals. The soil water was distilled from each sample and analyzed for natural tritium and the soil samples were analyzed for particle-size distribution. The upper 3 m of the stratigraphic section consists of coarse to heavy-textured interbedded lacustrine deposits. These units are underlain by a heavy-textured weathered till. The site is a zone of groundwater recharge with the water table at 9 m below the ground surface. Water, which entered the subsurface environment from ground surface after 1953, has migrated to the lacustrine-till contact via intergranular seepage and fracture flow, and fractures are transmitting post-1953 recharge water to depths within the underlying slowly-permeable unsaturated and saturated till. The origin of a broad tritium peak immediately below the water table may be the result of an increasing fracture density at this depth. In addition, diffusion of tritium from the fractures into the adjacent matrix material appears to occur both above and below the water table. (Moore-IVI)
W84-01691

AN INTEGRATED APPROACH TO HYDROGEOLOGIC INVESTIGATIONS - A CASE HISTORY,
Department of Agriculture, Lethbridge (Alberta).
M. J. Hendry, R. W. Gillham, and J. A. Cherry.
Journal of Hydrology, Vol. 63, No. 3-4, p 211-232, June, 1983. 11 Fig, 1 Tab, 13 Ref.

Descriptors: *Nitrates, *Groundwater, *Geohydrology, *Solute transport, *Denitrification, Sand aquifers, Geochemistry, Isotope studies, Simulation, Mathematical models.

Several investigative techniques were applied to occurrence and migration of nitrate in a thin (7-3 m) phreatic sand aquifer beneath agricultural land. At an early stage in the investigation, high nitrate concentrations were found at shallow depths in the aquifer, while at greater depth in the aquifer the nitrate concentration was close to zero. The interface between the shallow groundwater containing nitrate and the deeper nitrate-free water was sharp throughout the study area. Two explanations for the nitrate distribution were considered: the shallow high-nitrate water originated as infiltration through the soil of the study area and the deeper nitrate-free water entered the study area from upgradient of the study area; and the vertical nitrate distribution was the result of denitrification in the aquifer. Through the application of physical hydrogeologic methods of investigation (test drilling, groundwater instrumentation, hydraulic-head monitoring and hydraulic conductivity measurements), geochemical studies (major-ion analyses, pH, Eh, dissolved oxygen, methane and alkalinity), environmental isotope studies (O18, deuterium and tritium), numerical simulations of groundwater flow and solute transport and an analytical solution of solute transport, it was shown that denitrification is the principal cause of the nitrate distribution and the first hypothesis was invalid. Denitrification can be an important process in groundwaters on a regional scale. Without the application of an integrated approach, the importance of the denitrification process would probably not have been recognized and confirmed. Although not easily anticipated, it is possible that over-interpretation of results from any one of the study methods could have produced erroneous conclusions. (Moore-IVI)
W84-01692

ORIGIN OF DISSOLVED SOLIDS IN GROUNDWATERS OF MAYNE ISLAND, BRITISH COLUMBIA, CANADA,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
R. A. Dakin, R. N. Farvolden, J. A. Cherry, and P. Fritz.
Journal of Hydrology, Vol. 63, No. 3-4, p 233-270, June, 1983. 20 Fig, 3 Tab, 35 Ref.

Descriptors: *Dissolved solids, *Saline water, Groundwater, Hydrochemistry, Geohydrology, Isotope studies, Sodium, Chloride, Shale, Ground-

water movement, Meteoric water, Leaching, Brines, Molecular diffusion, Seawater.

Hydrogeological, hydrochemical and isotope techniques were applied to determine the origin of saline groundwaters on Mayne Island in the Strait of Georgia, British Columbia. The saline groundwater is a sodium chloride type, with concentrations of Na(+) and Cl(-) as high as 4367 and 8008 mg/l, respectively. Leach tests on twenty rock samples from boreholes indicate that the shale strata in the Cretaceous bedrock have Cl(-) concentrations ranging up to 900 ppm by weight and Na(+) concentrations up to 2070 ppm. The salt probably originated in the shale during periods of post-depositional compaction, or during periods of immersion in ocean water during episodes of glacial loading and erosion during Pleistocene time. The present flow regime of active flushing of meteoric water through the surficial sediments and sedimentary bedrock of Mayne Island began as the island emerged from below sea level during the last deglaciation. The salt content of the present-day groundwater can be accounted for by the slow release, through molecular diffusion, of Na(+) and Cl(-) from the low-permeability matrix of the shale to the active paths of groundwater flow in fractures in the shale and in sandstone strata. Intrusion of ocean water under the present hydrologic regime on the island, and upward flow of brine from deep zones within the regional sedimentary basin are believed to be relatively unimportant contributors of salt to the active groundwater flow systems. O18, deuterium and tritium concentrations are rather uniform for both surface waters and groundwaters on Mayne Island and a meteoric origin is suggested. Saline spring waters on an adjacent island were found to have high O18 and D concentrations (delta O18 = +6.5 0/00, delta O = -24 0/00), suggesting a sedimentary basin brine, but there is no evidence that these brines are mixing with Mayne Island groundwater. (Author's abstract)
W84-01693

VERTICAL RECHARGE TO A CONFINED LIMESTONE IN NORTHWEST SRI LANKA,
Institute of Hydrology, Wallingford (England).
A. R. Lawrence, and H. A. Dharmagunawardena.
Journal of Hydrology, Vol. 63, No. 3-4, p 287-297, June, 1983. 5 Fig, 2 Tab, 11 Ref.

Descriptors: *Groundwater recharge, *Confined aquifers, Leakage, Limestone aquifers, Recharge reservoir, Hydrochemistry, Pumping tests, Sri Lanka.

The water resources of a Miocene limestone aquifer in northwest Sri Lanka were investigated. The limestone aquifer receives recharge although it is buried beneath a thick sequence of Quaternary deposits of low permeability which cover the whole basin. Hydrochemical and pumping-test data show that this recharge occurs as leakage through the semi-permeable cover. The observed delay in a significant response of the water table within the semi-permeable cover to pumping of the limestone aquifer agrees well with theorectical predictions. This semi-permeable cover acts as a recharge reservoir allowing pumping from the limestone to proceed even during periods of extended drought. (Author's abstract)
W84-01695

DISSOLVED IONS, STABLE AND RADIOACTIVE ISOTOPES AND NOBLE GASES IN THERMAL WATERS OF SOUTH AFRICA,
University of the Witwatersrand, Johannesburg (South Africa). Nuclear Physics Research Unit.
For primary bibliographic entry see Field 2J.
W84-01696

INCORPORATION OF PRIOR INFORMATION ON PARAMETERS INTO NONLINEAR REGRESSION GROUNDWATER FLOW MODELS; 2. APPLICATIONS,
Geological Survey, Denver, CO.
R. L. Cooley.
Water Resources Research, Vol. 19, No. 3, p 662-676, June, 1983. 22 Fig, 5 Tab, 10 Ref.

Descriptors: *Groundwater movement, *Mathematical models, Nonlinear regression, Errors, Water level, Nevada, Washoe County, Truckee Meadows.

In projects involving groundwater modeling, two independent numerical data sets normally exist: a set of water level observations, called sample information, and a set of measurements or calculations of the system parameters, called prior information. Factors influencing the degree of improvement in estimates of parameters of a nonlinear regression groundwater flow model by incorporating prior information of unknown reliability were investigated. If the parameters are properly scaled, linearized expressions for the mean square error (MSE) in parameter estimates of a nonlinear model will often behave very nearly as if the model were linear. By using prior information, the MSE in properly scaled parameters can be reduced greatly over the MSE of ordinary least squares estimates of parameters. Plots of estimated MSE and the estimated standard deviation of MSE versus an auxiliary parameter (the ridge parameter) specifying the degree of influence of the prior information on regression results can help determine the potential for improvement of parameter estimates. Proposed criteria can be used to make appropriate choices for the ridge parameter and another parameter expressing degree of overall bias in the prior information. Results of a case study of Truckee Meadows, Reno-Sparks area, Washoe County, Nevada, conform closely to the results of the hypothetical problem. In the Truckee Meadows case, incorporation of prior information did not greatly change the parameter estimates from those obtained by ordinary least squares. Both sets of estimates are more reliable than suggested by the standard errors from ordinary least squares. (Moore-IVI)
W84-01709

A GEOSTATISTICAL APPROACH TO THE INVERSE PROBLEM IN GROUNDWATER MODELING (STEADY STATE) AND ONE-DIMENSIONAL SIMULATIONS,
Iowa Univ., Iowa City. Inst. of Hydraulic Research.
P. K. Kitanidis, and E. G. Vomvoris.
Water Resources Research, Vol. 19, No. 3, p 677-690, June, 1983. 10 Fig, 44 Ref. NSF grant CME-8106577.

Descriptors: *Permeability, *Hydraulic head, *Groundwater, Mathematical modeling, Simulation, Geostatistics, Geohydrology.

The problem of estimating hydrogeologic parameters, in particular, permeability, from input-output measurements is reexamined in a geostatistical framework. The field of unknown parameters is represented as a 'random field' and the estimation procedure consists of two main steps. First, the structure of the parameter field is identified, i.e. mathematical representations of the variogram and the trend are selected and their parameters are established by using all available information, including measurements of hydraulic head and permeability. Second, linear estimation theory is applied to provide minimum variance and unbiased point estimates of hydrogeologic parameters (kriging). Structure identification is achieved iteratively in three substeps: structure selection, maximum likelihood estimation, and model validation and diagnostic checking. The methodology was extensively tested through simulations on a simple one-dimensional case. The results are remarkably stable and well behaved. The estimated field is smooth, while small-scale variability is statistically described. As the quality of measurements improves, the procedure reproduces more features of the original field. The results are also shown to be rather insensitive to deviations from assumptions about the geostatistical structure of the field. (Author's abstract)
W84-01710

EXPERIMENTAL INVESTIGATIONS OF UNCONFINED AQUIFER POLLUTION FROM RECHARGE BASINS,
Atomic Energy of Canada Ltd., Pinawa (Manitoba).
For primary bibliographic entry see Field 5B.
W84-01713

NUMERICAL STUDIES OF THE HEAT AND MASS TRANSPORT IN THE CERRO PRIETO GEOTHERMAL FIELD, MEXICO,
California Univ., Berkeley. Lawrence Berkeley Lab.
M. J. Lippmann, and G. S. Bodvarsson.
Water Resources Research, Vol. 19, No. 3, p 753-767, June, 1983. 22 Fig, 5 Tab, 34 Ref. DOE contract DE-AC03-76SF00098.

Descriptors: *Geothermal resources, *Mass transfer, *Heat, Mathematical models, Simulation, Groundwater recharge, Computer models, Cerro Prieto Geothermal Field, Mexico.

Numerical simulation techniques are employed in studies of the natural flow of heat and mass through the Cerro Prieto reservoir, Mexico and of the effects of exploitation on the field's behavior. The reservoir model is a two-dimensional vertical east to west-southwest cross section, which is based on a recent hydrogeologic model of this geothermal system. The numerical code MULKOM is used in the simulation studies. The steady state pressure and temperature distributions are computed and compared against observed pre-production pressures and temperatures: a reasonable match is obtained. A natural hot water recharge rate of about 0.001 kg/s per meter of field length (measured in a north-south direction) is obtained. The model is then used to simulate the behavior of the field during the 1973-1978 production period. The response of the model to fluid extraction agrees to what has been observed in the field or postulated by other authors. There is a decrease in temperatures and pressures in the produced region. No extensive two-phase zone develops in the reservoir because of the strong fluid recharge. Most of the fluid recharging the system comes from the colder regions located above and west of the produced reservoir. (Author's abstract)
W84-01719

EFFICIENT FINITE ELEMENT TECHNIQUE FOR MODELING TRANSPORT IN FRACTURED POROUS MEDIA; 1. SINGLE SPECIES TRANSPORT,
GeoTrans, Inc., Reston, VA.
P. S. Huyakorn, B. H. Lester, and J. W. Mercer.
Water Resources Research, Vol. 19, No. 3, p 841-854, June, 1983. 15 Fig, 5 Tab, 21 Ref. DOE contract E512-02900.

Descriptors: *Solute transport, *Porous media, *Geologic fractures, Mathematical models, Simulation, Differential equations, Diffusion.

A mathematical model is presented for numerical simulation of solute transport in naturally fractured porous media. The model is based on the dual-porosity conceptual approach and is capable of simulating interactions between porous rock matrix and fractures. Unlike earlier dual-porosity transport models, which rely on parallel fracture assumptions, the present model is a unified model that is also able to represent blocky fractured systems (i.e., systems with suborthogonal fractures) by using a spherical idealization of matrix blocks. Two governing, partial differential equations are written for solute transport in the fractures and diffusion in the porous matrix blocks. These equations are coupled by mass flux terms (leakages). An efficient numerical scheme is presented for approximating the governing transport equations. The scheme effectively combines a two-dimensional, upstream-weighted, finite-element approximation for transport in the fractures with a one-dimensional Galerkin approximation for diffusion within the individual matrix blocks. Coupling of the two approximations is performed implicitly. The systems of algebraic equations resulting from both finite-element approximations are solved by using sequential solution algorithms designed especially for this type of problem. Stability and accuracy of the numerical scheme are checked by applying the model to a number of test problems and comparing results with available analytical

solutions. In all cases the numerical scheme is found to be highly stable and capable of producing reliable results with the use of relatively coarse spatial and temporal discretizations. Finally, the utility of the model is demonstrated by applying it to a hypothetical, yet realistic, problem. (Author's abstract)
W84-01726

2G. Water In Soils

EXTRACTION AND CHEMICAL ANALYSIS OF INTERSTITIAL WATER FROM SOILS AND ROCKS,
Institute of Geological Sciences, London (England). Hydrogeology Unit.
D. G. Kinniburgh, and D. L. Miles.
Environmental Science and Technology, Vol. 17, No. 6, p 362-368, June, 1983. 2 Fig, 7 Tab, 19 Ref.

Descriptors: *Interstitial water, *Soil water, Chalk, Solutes, Chemical analysis, Clays, Organic carbon, Spectrometry, Topsoil.

Interstitial water was extracted from field-moist soils and chalk by immiscible displacment with a dense, inert fluorocarbon liquid. The only special equipment required is a high-speed centrifuge. Yields of interstitial water from soils at field capacity are typically 20-50% of the total water present; yields from chalk range up to 90%. The interstitial water was analyzed for about 20 solutes principally by inductively coupled plasma emission spectrometry. The water extracted from a chalk sample appeared to be representative of all the water present, but with a clay soil, there was evidence of some fractionatiion of NO3-N. Organic carbon (0.002 to 0.007 M) was frequently the most abundant solute in the solutions extracted from ten topsoils. Other typical solute concentrations were in the range 0.001 to 0.0001 M for NO3-N, Na, Mg, Si, S, Cl, K, and Ca and less than 0.000001 M for the trace elements Cu, Zn, and Ba. (Author's abstract)
W84-01505

COMPETITIVE ADSORPTION DURING SOLUTE TRANSPORT IN SOILS: 1. MATHEMATICAL MODELS,
Western Australia Univ., Nedlands. Dept. of Soil Science and Plant Nutrition.
V. Murali, and L. A. Aylmore.
Soil Science, Vol. 135, No. 3, p 143-150, March, 1983. 22 Ref.

Descriptors: *Leaching, *Mathematical models, *Solute transport, Adsorption, Soil-water-plant relationships, Competitive adsorption, Isotopic exchange, Convection, Dispersion.

One-dimensional, convective-dispersive-adsorptive flow models, in Cartesian and polar coordinates, representing flow of chemicals in soils (e.g., leaching) and toward plant roots, are generalized to competitive multispecies systems. Langmuir-type competitive adsorption models suitable for equilibrium and dynamic interactions are presented, and a few special simplified cases are discussed. Freundlich-type equilibrium adsorption models are modified to multispecies situations. An empirical approach, capable of handling most general equilibrium adsorption isotherms, suitable for multispecies systems, is also described. The empirical approach is comparable to equilibrium Langmuir and Freundlich-type competition in binary systems. Isotopic exchange, which is a form of competition between isotopes of the species for adsorption or exchange sites, may be described through a simple McKay-type equation. (Author's abstact)
W84-01596

ESTIMATING SOIL MOISTURE STORAGE IN THE ROOT ZONE FROM SURFACE MEASUREMENTS,
Computer Sciences Corp., Silver Spring, MD.
P. Camillo, and T. J. Schmugge.
Soil Science, Vol. 135, No. 4, p 245-264, April, 1983. 18 Fig, 9 Tab, 21 Ref.

Descriptors: *Soil water, *Mathematical models, *Simulation, *Roots, Soil water suction, Soil texture, Root zone, Remote sensing, Matric suction profile.

Numerical simulations of the dynamics of soil water in the root zone of a vegetated field show that the matric suction profile can eventually acquire the same shape as the relative root density profile. The suction at any depth is proportional to the corresponding root density raised to a power that depends on soil texture. This behavior is found only for fully grown root systems when the soil water distribution is controlled primarily by the water absorption by the roots; this becomes more likely as the soil dries out. That this power law is a solution of the continuity equation will also be demonstrated analytically. This functional relationship is used to show that, under these restrictive conditions, root zone soil moisture storage is a linear function of volumetric moisture at a particular depth, with the slope changing with depth but fixed in time. This hypothesis is supported by both laboratory and field soil moisture profile measurements, which were taken in fields with fully grown plants. No other model parameters need to be estimated, and the good agreement found constitutes an independent validation of the soil water extraction model under the plant and soil conditions described. Potential applications of these results include estimating soil moisture storage in the root zone from remotely sensed surface soil moisture and estimating the root profile from matric potential profile measurements. (Author's abstract)
W84-01598

GROUNDWATER RECHARGE THROUGH A HEAVY-TEXTURED SOIL,
Department of Agriculture, Lethbridge (Alberta). Irrigation Div.
For primary bibliographic entry see Field 2F.
W84-01691

SIMULATION MODEL OF THE WATER BALANCE OF A CROPPED SOIL: SWATRE,
Instituut voor Cultuurtechniek en Waterhuishouding, Wageningen (Netherlands).
C. Belmans, J. G. Wesseling, and R. A. Feddes.
Journal of Hydrology, Vol. 63, No. 3-4, p 271-286, June, 1983. 6 Fig, 27 Ref.

Descriptors: *Soil-water-plant relationships, *Mathematical models, *Water uptake, *Roots, Soil water, Boundary conditions, Rainfall, Evaporation, Transpiration, Soil saturation.

A transient one-dimensional finite-difference model for the unsaturated zone with water uptake by roots is presented. A number of boundary conditions is given for the top and the bottom of the system. At the top, 24-hr. data on rainfall, potential soil evaporation and potential transpiration are needed. When the soil system remains unsaturated, one of the three bottom boundary conditions can be used: pressure head, zero flux or free drainage. When the lower part of the system remains saturated, one can either give the groundwater level or the flux through the bottom of the system as input. In the latter case the groundwater level is computed. (Author's abstract)
W84-01694

GAMMA NEUTRON METHOD APPLIED TO FIELD MEASUREMENT OF HYDRODYNAMIC DISPERSION,
Montpellier-2 Univ. (France). Lab. d'Hydrologie Mathematique.
F. Brissaud, A. Pappalardo, and Ph. Couchat.
Journal of Hydrology, Vol. 63, No. 3-4, p 331-343, June, 1983. 6 Fig, 1 Tab, 13 Ref.

Descriptors: *Solute transport, *Irrigation effects, Hydrodynamics, Dispersion, Pore water, Gamma neutron method, Deuterium.

Solute movements during field irrigations were studied under steady-state and transient hydrodynamic conditions. The gamma neutron method was used to monitor a deuterated water pulse along a vertical profile in field test plots. Two different types of behavior were revealed by the test results. In the first, the labeled water pulse velocity matches the conservation of the vertical rate of water and, when the deuterated water concentration profiles are mass-conservative, the experimental results are accurately described by the equation of dispersion. In the second, the pore water velocity differs considerably from that of strictly vertical displacements and the concentration profiles are not mass-conservative. Two tests carried out on the same plot under similar conditions several weeks apart can show both types of behavior. (Moore-IVI)
W84-01697

UNSTEADY FLOW AGAINST DISPERSION IN FINITE POROUS MEDIA,
Banaras Hindu Univ., Varanasi (India). Dept. of Mathematics.
N. Kumar.
Journal of Hydrology, Vol. 63, No. 3-4, p 345-358, June, 1983. 4 Fig, 1 Tab, 15 Ref.

Descriptors: *Unsteady flow, *Dispersion, Porosity, Flow, Velocity, Water quality, Mathematical studies.

Analytical solutions are presented for dispersion (in a finite non-adsorbing and adsorbing porous medium) which is controlled by flow (with unsteady unidirectional velocity distribution) of a low concentration fluid towards a region of higher concentration. Such a situation often occurs in practice when poor quality water is prevented from spreading by a flow of fresh water. An exponential function concentration is enforced at the source of dispersion, while zero concentration, or a condition in which the change in concentration is proportional to the flow, is applied at the other boundary. A new time variable has been introduced to solve the unsteady flow problem. By observing the flow velocities initially and at different times as the flow advances, the time variable can be calculated. (Moore-IVI)
W84-01698

GEOSTATISTICAL APPROACH TO THE TRICKLE IRRIGATION DESIGN IN HETEROGENEOUS SOIL; 1. THEORY,
Agricultural Research Organization, Bet-Dagan (Israel). Div. of Soil Physics.
D. Russo.
Water Resources Research, Vol. 19, No. 3, p 632-642, June, 1983. 9 Fig, 21 Ref.

Descriptors: *Trickle irrigation, *Permeability coefficient, *Soil water, *Head, *Irrigation design, Spatial distribution, Crop yield, Soil hydraulics, Statistical methods, Geostatistics.

A geostatistical approach was used to investigate the spatial variability of two measured soil hydraulic parameters, the saturated hydraulic conductivity Ks and alpha = d(log K(h))/(d(h)), where K is the hydraulic conductivity and h is the soil water pressure head. Using a linearized solution to steady infiltration from a circular shallow pond, the spatial distribution of the midway soil water pressure head between emitters, he (for a given trickle discharge rate Q and spacing between emitters, d), was calculated using the spatially variable soil parameters K, and alpha. The spatial distribution of the crop yield Y was calculated from the spatially variable he by using a quadratic expression of the Y(he) relationships. It was found that the spatial variability of each of the measured input parameters (Ks and alpha) or the calculated output variables (he and Y) is expressed through the variogram gamma and can be characterized in terms of the coefficient of variation CV and the integral scale J. In the case of log Ks, for which the sill is reached at relatively small range, two different gammas were tested. Results showed that the kriged values of log Ks as well as the resultant values of he = he(Ks alpha; d, Q) were relatively insensitive to the selected gamma. The spatial variability of he reduced the average (over the field) crop yield that would have been obtained when he was uniform throughout the field. The spatially variable soil parameters Ks and alpha were used to calculate the

spatial distribution of the spacing between emitters (d) required to achieve (for a given trickle discharge) a prespecified value of he uniform throughout the field. It was found that the use of a spatially variable d increased the field crop yield by 3% relative to the yield that was obtained when a single-valued d uniform throughout the field was used. The spatial distribution of d was combined with hydraulic principles to derive the spatial distribution of lateral diameter and length for engineering design requirements. (Author's abstract)
W84-01706

MODELING TRITIUM AND CHLORIDE 36 TRANSPORT THROUGH AN AGGREGATED OXISOL,
California Univ., Davis. Dept. of Land, Air and Water Resources.
P. Nkedi-Kizza, J. W. Biggar, M. Th. van Genuchten, P. J. Wierenga, and H. M. Selim.
Water Resources Research, Vol. 19, No. 3, p 691-700, June, 1983. 11 Fig, 5 Tab, 27 Ref.

Descriptors: *Soil water, *Chloride, *Solute transport, Breakthrough, Steady flow, Saturated soils, Simulation, Mathematical models, Convection, Diffusion, Isotopic tracers, Interstitial water, Velocity, Tritium.

Breakthrough curves (BTC's) of tritiated H2O and Cl36 simultaneously displaced through columns of various-sized aggregates of an Ione Oxisol soil were measured under water-saturated steady flow conditions. The data were simulated using two conceptual models. In model I, all soil water was assumed to be mobile with a physical equilibrium existing in the system. For model II, soil water was partitioned into mobile and immobile regions. Convective diffusive solute transport was limited to the mobile water region. Transfer of a tracer between the two soil water regions was assumed to occur at a rate proportional to the difference in tracer concentrations between the two regions. Sorption of labeled H20 and Cl36 was considered to be an instantaneous linear and reversible process. The two unknown parameters in model I and the four unknown parameters in model II were estimated by fitting model predictions to the experimental data. Model I could only describe BTC's obtained from columns packed with small aggregates (0.5-1 mm) and for displacements run at small fluxes (0.2 cm/h), whereas model II described all the BTC's well. Peclet numbers P in model II, as measured on each separate column, were essentially constant, indicating a linear relationship between the apparent diffusion coefficient D and the mobile pore water velocity vm. The fraction of soil water that is mobile, phi, and the mass transfer coefficient alpha were found to be a function of the physical and chemical properties of the porous medium (aggregate size, pore water velocity, and solution concentration). (Author's abstract)
W84-01711

ESTIMATING SPATIAL VARIABILITY IN SOIL MOISTURE WITH A SIMPLIFIED DYNAMIC MODEL,
Maryland Univ., College Park. Dept. of Civil Engineering.
R. B. Clapp, G. M. Hornberger, and B. J. Cosby.
Water Resources Research, Vol. 19, No. 3, p 739-745, June, 1983. 5 Fig, 3 Tab, 16 Ref.

Descriptors: *Soil water, *Mathematical models, *Spatial variability, Topography, Soil physical properties, Scaling theory, Wetting front, Simulation, Infiltration, Precipitation, Chickasha, Oklahoma.

Topographic effects, soil heterogeneity, and spatial variability in precipitation and vegetation may induce variability in measured soil moisture. Scaling theory has been suggested as a promising tool for describing soil heterogeneity and, consequently, a portion of spatial variability of measured soil moisture. The appropriateness of ascribing soil moisture variability to heterogeneity of soil properties is investigated through the use of a model of soil moisture dynamics and scaling theory. The model, termed a wetting front model, is a simplified representation of water movement in soils. The model conceptually depicts the moisture profile as discrete blocks of soil moisture separated by sharp fronts. Probabilistic simulations were run with input data appropriate to watersheds R-5 and R-7 at Chickasha, Oklahoma. Variability due to soil heterogeneity remains relatively constant through time with only slight increases during redistribution following infiltration. A comparison of simulated and observed soil moisture integrated from the surface to the 15-cm depth shows that heterogeneity in soil hydraulic properties may account for approximately 75% of observed standard deviation, or 56% of the variance. By ascribing all of the uncertainty in a soil system to scaled differences in the soil matrix, one may be limiting the mathematical simulator to a certain pattern in the variability in the computed moisture content. (Moore-IVI)
W84-01717

RAINWATER INFILTRATION INTO A BARE LOAMY SAND,
Central Arid Zone Research Inst., Jodhpur (India).
K. D. Sharma, H. P. Singh, and O. P. Pareek.
Hydrological Sciences Journal, Vol. 28, No. 3, p 417-424, September, 1983. 4 Fig, 2 Tab, 14 Ref.

Descriptors: *Infiltration, *Rainfall, *Rainfall impact, *Slope, Soil surfaces, Water harvesting, Slope length, Loamy sand, India.

In order to design micro-catchment water harvesting systems in the Indian desert, rainwater infiltration experiments were conducted on a representative loamy sand soil for a period of six years. Plots with three slopes - 0.5, 5 and 10%, and five slope lengths - 5.12, 7.0, 8.5, 10.75 and 14.5 m were used. With dry antecedent soil conditions, infiltration is governed by rainfall depth, whereas with wet antecedent soil conditions, raindrop impact (intensity) which forms a crust over the soil surface, is the deciding factor. Infiltration decreases significantly with increasing slope due to reduction in the time available for rainfall to infiltrate, but slope length has no significant effect. A graphical multiple curvilinear model to predict rainfall infiltration using rainfall and basin characteristics is developed and the goodness of fit is tested. (Author's abstract)
W84-01765

2H. Lakes

DISTRIBUTION AND ABUNDANCE OF LARVAL BURBOT AND DEEPWATER SCULPIN IN LAKE MICHIGAN,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
P. J. Mansfield, D. J. Jude, D. T. Michaud, D. C. Brazo, and J. Gulvas.
Transactions of the American Fisheries Society, Vol. 112, No. 2A, p 162-172, March, 1983. 5 Fig, 2 Tab, 42 Ref.

Descriptors: *Burbot, *Sculpin, *Larvae, *Lake Michigan, Spawning, Distribution, Entrainment, Water temperature, Fish populations.

Samples from seven locations at depths to 21 m, collected over periods of up to 8 years, were used to describe the nearshore distribution and abundance of burbot Lota lota and deepwater sculpin Myoxocephalus thompsoni larvae in Lake Michigan. Based upon power-plant-entrainment samples and field collections, burbot larvae (3.0-7.5 mm) occurred from late March to mid-June, most abundantly in April and May, and most often at water temperatures of 6-12 C. Larvae were collected from the 0.5- to 13.5-m depth strata as far lakeward as the 21-m bottom contour, the limit of offshore sampling. In eastern Lake Michigan, highest densities (up to 843 larvae/1,000 cu m) were at the 1-m contour; in Green Bay, up to 24,000 larvae/1,000 cu m were detected near the Bark River. High densities of burbot larvae at bottom depths 3 m and less indicated inshore spawning and river spawning at some sites. Deepwater sculpin larvae first occurred in early February and were common in March and April entrainment samples. Larvae (8.0-22.0 mm) were in nearshore waters usually through May at depth strata of 0.5 to 17 m as far lakeward as the 18-m bottom contour. Most larvae occurred at water temperatures below 6 C. Field densities were low, 5 to 78 larvae/1,000 cu m. Deepwater sculpin larvae were pelagic and were dispersed over great distances by currents. (Author's abstract)
W84-01401

COMPARISON OF TWO ICHTHYOPLANKTON SAMPLING GEARS WITH NOTES ON MICRODISTRIBUTION OF FISH LARVAE IN A LARGE RIVER,
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
For primary bibliographic entry see Field 7B.
W84-01406

DIEL DRIFT AND FEEDING OF CHANNEL CATFISH ALEVINS IN THE ILLINOIS RIVER, ARKANSAS,
Arkansas Game and Fish Commission, Hot Springs.
M. L. Armstrong, and A. V. Brown.
Transactions of the American Fisheries Society, Vol. 112, No. 2B, p 302-307, March, 1983. 1 Fig, 1 Tab, 35 Ref.

Descriptors: *Fish, *Larvae, *Drift, *Fish food, Catfish, Alevins, Invertebrates, Midges, Water currents, Illinois River, Arkansas.

The downstream displacement, or drift, of fish larvae in lotic ecosystems has, in addition to its intrinsic interest, practical importance whenever withdrawals of water are contemplated for industrial or other uses. It is not clearly understood why larval fish drift, but it has been suggested that the fish are feeding on drifting invertebrates. The food habits of 317 channel catfish Ictalurus punctatus alevins (standard length 14-16 mm) collected from the Illinois River, Arkansas were investigated to determine if the drifting alevins were using drifting invertebrates as a food resource. Drift of alevins coincided with increases in fullness of their stomachs, but alevins had been feeding predominantly on chironomid larvae and pupae, which were rare in the drift and riffle substrate. Alevins apparently fed on chironomids in upstream pools and accidentally encountered swift currents that caused them to drift downstream. If so, drift was a consequence of feeding activity, not an aid to it. (Moore-IVI)
W84-01409

SPAWNING AND EARLY-LIFE ECOLOGICAL PHASES OF THE WHITE SUCKER IN JACK LAKE, ONTARIO,
Trent Univ., Peterborough (Ontario). Dept. of Biology.
B. Corbett, and P. M. Powles.
Transactions of the American Fisheries Society, Vol. 112, No. 2B, p 308-313, March, 1983. 5 Fig, 3 Tab, 23 Ref.

Descriptors: *Sucker, *Spawning, Growth, Water temperature, Drift, Fish food, Hatching, Marinas, Channels, Jack Lake, Ontario.

In 1979, peak spawning of white suckers Catostomus commersoni occurred on April 20-21 (9-15 C and 17-22 C) at night over fast riffle in a tributary of Jack Lake. Eggs hatched in 16 days and drift occurred in 27-29 days; maximum drift occurred between 2100 and 0100 hours. An estimated 11,800 postlarvae drifted to the nursery, a new boat channel and marina area in Jack Lake. Postlarvae phase 1 (terminal mouth, 15-17 mm total length, TL) and phase 2 (subterminal mouth, 18-34 mm TL) were spent in the nursery. At 28 C (midsummer), phase-3 fish (35-84 mm TL) moved out to the lake shores near the nursery, and later dispersed into the lake basin. Growth of white suckers was slower in phase 1 than in phase 2, and diets differed slightly between these intervals. Phase-3 fish did not grow significantly faster than phase-2 fish in spite of their more diverse diet. The cooler lake habitat may account for a lack of surge in the growth rate of phase-3 fish, or diversity of food may be an indica-

tion of food scarcity away from the nutrient-rich nursery area. (Author's abstract)
W84-01410

IDENTIFICATION OF CATOSTOMID LARVAE IN PYRAMID LAKE AND THE TRUCKEE RIVER, NEVADA,
Colorado State Univ., Fort Collins. Larval Fish Lab.
D. E. Snyder.
Transactions of the American Fisheries Society, Vol. 112, No. 2B, p 333-348, March, 1983. 10 Fig, 5 Tab, 37 Ref.

Descriptors: *Spawning, *Larvae, *Suckers, Distribution, Pyramid Lake, Truckee River, Nevada.

As adults, mountain suckers Catostomus platyrhynchus inhabit the Truckee River, Tahoe suckers Catostomus tahoensis both the river and Pyramid Lake, and the endangered cui-ui Chasmistes cujus the lake only, except during the spawning season. All spawn in the river and under certain conditions the latter two species also spawn in the lake. The development of adequate water and fishery management techniques to insure the survival of the endangered cui-ui requires knowledge of the fish'. reproductive and early life history requirements. Diagnostic characters useful in identifying most larvae and early juveniles include differences in pigmentation, size at the onset of specific developmental events, and gut and mouth morphologies. Fin-ray counts, myomere counts, and morphometric characters are very similar and of little diagnostic value. Based on these criteria, larvae of the cui-ui were identified in Pyramid Lake collections, and larvae and juveniles of the mountain and Tahoe suckers were identified in both lake and river collections. All the cui-ui were taken in the lake substantial distances from the Truckee River delta, and may represent natural spawning in Pyramid Lake during 1974 and 1975. The presence of mountain suckers in Pyramid Lake had not been previously documented. (Moore-IVI)
W84-01411

MICROHABITATS CHOSEN BY BROWN TROUT FOR FEEDING AND SPAWNING IN RIVERS,
C. S. Shirvell, and R. G. Dungey.
Transactions of the American Fisheries Society, Vol. 112, No. 3, p 355-367, May, 1983, 5 Fig, 7 Tab, 31 Ref.

Descriptors: *Trout, *Spawning, *Feeding, Aquatic habitats, Water depth, Velocity, Fish population, Population dynamics, Substrates, Rivers, New Zealand.

This study's objective was to quantify the water depth, water velocity, and substrate used by adult brown trout Salmo trutta for feeding and spawning in rivers. General hypotheses were: (1) brown trout prefer specific magnitudes of environmental variables and occupy positions through choice; (2) the preferred value of any variable for a particular activity is the same in all rivers; (3) brown trout prefer different values of the same variable for different activities. Surface observation was used to locate 140 feeding and 140 spawning positions used by brown trout in both isolated and sympatric (with rainbow trout Salmo gairdneri) populations in six diverse rivers in New Zealand. Brown trout (mean fork length 42 cm) preferred a mean depth of 65.0 cm and a mean velocity of 26.7 cm/sec at the position occupied by the fish for feeding, but for spawning they preferred a mean depth of 31.7 cm, a mean velocity of 39.4 cm/sec, and a mean substrate size of 14.0 mm. Analysis of variance showed brown trout preferred the same velocity for the same activity in all rivers and years regardless of whether they were from allopatric or sympatric populations, but microhabitats used for feeding and spawning were significantly different. Velocity appeared to be the most important factor determining position choice but ranking of factors may vary with the type of activity. Brown trout chose positions with optimum combinations of depth and velocity instead of positions with more preferred values of either factor alone. Population size maybe limited by the amount of the least abundant activity-specific microhabitat. (Author's abstract)
W84-01412

COMMUNITY ANALYSIS IN FISHERY MANAGEMENT: AN APPLICATION WITH NORTHERN WISCONSIN LAKES,
Wisconsin Univ.-Madison. Center for Limnology.
W. M. Tonn, J. J. Magnuson, and A. M. Forbes.
Transactions of the American Fisheries Society, Vol. 112, No. 3, p 368-377, May, 1983. 5 Fig, 2 Tab, 43 Ref. DEB 79-12337, F-83-R.

Descriptors: *Fisheries, *Lakes, Aquatic habitats, Management, Biological communities, Multivariate analysis, Fish, Water depth, Hydrogen ion concentration, Conductivity, Watersheds, Lake area, Wisconsin.

Decisions in fishery management usually are made on a species-by-species and site-by-site basis because most information about fishes has been collected and organized in this way. A comparative, community-level approach can contribute to the development of management strategies for large sets of lakes and fish assemblages. An approach similar in concept to lake classification uses a technique of multivariate community analysis (ordination, classification, multiple discriminant analysis). This approach can reveal patterns among fish assemblages and relate them to the lakes' habitat characteristics. An application of the approach is illustrated by a published study on fish assemblages of 18 small lakes in northern Wisconsin. Two discrete assemblage types were distinguished and the factors believed to be responsible for their maintenance were identified. With relationships derived from those 18 lakes, predictions of the assemblage types of 11 additional lakes are made from only five habitat characteristics obtained from the literature. The five environmental variables include lake area, maximum depth, pH, watershed size, and conductivity. Analyses showed these predictions to be largely successful. It is suggested that multivariate community analysis contributes to an ability to understand, predict, and manage fish assemblages. (Moore-IVI)
W84-01413

CHANGES IN FISH POPULATIONS OVER AN 80-YEAR PERIOD: BIG PINE LAKE, WISCONSIN,
Wisconsin Univ.-Madison. Center for Limnology.
P. D. Inskip, and J. J. Magnuson.
Transactions of the American Fisheries Society, Vol. 112, No. 3, p 378-389, May, 1983. 5 Fig, 4 Tab, 37 Ref.

Descriptors: *Fish populations, Muskellunge, Walleye, Pike, Bass, Population dynamics, Lake fisheries, Sport fishing, Temperature, Big Pine Lake, Wisconsin.

From 1897 to 1977, landowners recorded sport catches for Big Pine Lake, a 256 hectare lake in northern Wisconsin that has experienced light fishing pressure. The species composition of the catch remained fairly stable for 40 years, from 1897 to 1940, with muskellunge Esox masquinongry, walleye Stizostedion vitreum vitreum, and black bass (Micropterus spp.) all accounting for substantial fractions of the total. Northern pike Esox lucius were first recorded in 1946, apparently having entered after an outlet dam washed out in 1944. Subsequent increases in the proportion of northern pike coincided with declining percentages of muskellunge. By the 1950s, the relative abundance of walleye declined, ultimately almost to zero, while the percentage of bass more than doubled. This change began during the warmest decade on record. By 1977, the walleye population had rebounded, bass had declined to pre-1940 levels, northern pike were abundant, and muskellunge were relatively scarce. Long-term changes in summer temperatures and colonization by northern pike appear to have been important factors causing changes in species composition. Effects of human exploitation have been slight. Although the species composition changed dramatically over the 80 years, the only sustained change has been the substitution of northern pike for muskellunge. (Author's abstract)
W84-01414

COMMUNITY STRUCTURE DYNAMICS OF EPILITHIC AND EPIPHYTIC DIATOMS IN A MISSISSIPPI STREAM,
Mississippi State Univ., Mississippi State. Dept. of Biological Sciences.
R. O'Quinn, and M. J. Sullivan.
Journal of Phycology, Vol. 19, No. 2, p 123-128, June, 1983. 2 Fig, 3 Tab, 25 Ref. A-133-MISS.

Descriptors: *Diatoms, *Aquatic habitats, Biological communities, Stream biota, Epilimnion, Epiphton, Species diversity, Light intensity, Substrates, Seasonal variation, Mississippi.

Epilithic and epiphytic diatoms were collected monthly from 18 June 1979 through 19 May 1980 from both shaded and unshaded sites of Sessums Creek, a shallow, oligotrophic and strongly alkaline stream in northeastern Mississippi. The dominant macroalgae were filamentous green algae belonging to the nonmucilage producing genera Cladophora and Rhizoclonium. Ninety taxa were identified, with Navicula minima Grun. and Nitzschia dissipata (Kutz) Grun. accounting for 50% of all valves counted. Other important taxa were Navicula meniculus var. upsaliensis (Grun.) Grun., N. cryptocephala var. veneta (Kutz) Rabh., Achnanthes minutissima Kutz. and Cymbela turgida (Greg) Cl. With few exceptions, the more dominant taxa were equally abundant in the shaded and unshaded sites and also in the epilithon and epiphyton. Species diversity (H') and the number of taxa in a sample in all four habitats showed an identical pattern, being lowest in winter and highest in fall. No one pair of habitats were more structually similar than any other pair when compared by a similarity index (SIMI). Apparently, differences in light intensity and substrate type had little effect on diatom distribution in Sessums Creek and it was concluded that the locality sampled supported a single, nearly homogeneous diatom community. (Author's abstract)
W84-01447

MULTIVARIATE ASSESSMENT OF ENVIRONMENTAL PREFERENCES OF CYPRINID FISHES OF THE ILLINOIS RIVER, OKLAHOMA,
Oklahoma Biological Survey, Norman.
J. D. Felley, and L. G. Hill.
American Midland Naturalist, Vol. 109, No. 2, April, 1983. 1 Fig, 6 Tab, 24 Ref.

Descriptors: *Fish, *Aquatic environment, Illinois River, Oklahoma, Spatial distribution, Fish behavior, Fish food, Aquatic habitats, Spawning, Water temperature, Upstream, Downstream, Velocity.

Cyprinid fishes were collected from the Oklahoma drainage of the Illinois River in all seasons of 1978 and 1979. The Illinois River and its tributaries drain the Ozark Plateau and the Boston Mountains and support an Ozarkian Fish fauna. Species included in this analysis were Campostoma anomalum, Nocomis asper, Notropis boops, N. nubilus, N. pilsbryi, N. rubellus, N. whipplei, Pimephales notatus, Phoxinus erythrogaster and Semotilus atromaculatus. Fishes were collected and 17 environmental variables measured from each of 15 localities sampled in every season. Species distributions were characterized in reference to each variable as follows: the value of a variable at each location was weighted by the number of individuals of a species present, and the mean of these weighted values was taken as that species' preferred state for that variable. Principal components analysis, with rotation of the component solution to simple structure, was used to elucidate the relationships among variables in terms of species distributions. In most seasons, components related to species preferences for upstream vs. downstream locations, different foods, and slow- vs. fast-water habitats. For most species, differences in habitat preference between seasons were related to breeding (in the spring) and to preference for warmer

locations during the rest of the year. (Author's abstract)
W84-01449

CHLOROPHYLL A AND ADENOSINE TRIPHOSPHATE LEVELS IN ANTARCTIC AND TEMPERATE LAKE SEDIMENTS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
G. M. Simmons, Jr., R. A. Wharton, Jr., B. C. Parker, and D. Andersen.
Journal of Microbial Ecology, Vol. 9, No. 2, p 123-135, July, 1983. 2 Fig, 7 Tab, 50 Ref. 76-23996, 79-20805.

Descriptors: *Adenosine triphosphate, *Chlorophyll a, *Lake sediments, Trophic level, Antarctic, Temperate zone, Benthic algae, Microorganisms, Mictic state.

Analysis of adenosine triphosphate (ATP) from surficial sediment layers in two antarctic lakes and two temperate lakes showed a high degree of similarity in spite of differences between trophic state, mictic state, or geographic location. Adenosine triphosphate was found at all levels sampled in temperate lake sediment cores but occasionally was present only in surficial layers of antarctic cores. Surficial sediment layers from antarctic lakes contained high chlorophyll a (Chl a) levels due to the extensive benthic algal mats which occur there. In some antarctic cores, Chl a was detectable in deep, old mat layers, whereas Chl a was not found in any of the temperate lake cores. Antarctic lake sediments appear to be unique environments where Chl a molecules can remain intact for long periods of time due to low light, temperature, and microbial activity. As such, these lakes are important natural laboratories where a long history of microbial interations can be studied without metazoan perturbation effects. Although there was much variability in concentration of Chl a and ATP between samples, there appears to be no relationship between Chl a or ATP levels to mictic or trophic states of the lakes. These data suggest that sediment microbial communities may be independent of environmental and biological properties of the overlying water masses. (Author's abstract)
W84-01472

AXISYMMETRIC VERTICAL CIRCULATION IN A STRATIFIED RESERVOIR,
Technical Univ. of Szczecin (Poland). Inst. of Water Engineering.
Z. Meyer.
Journal of Hydraulic Research, Vol. 21, No. 2, p 133-151, 1983. 10 Fig, 12 Ref.

Descriptors: *Water circulation, *Reservoirs, Mathemetical models, Density stratification, Eddies, Selective withdrawal.

A mathematical model of vertical circulation in a density-stratified reservoir is presented for the case of axially symmetric flow, particularly for the flow generated by selective withdrawal. The method involves conditions such as location of intake, stratified flow parameters, and various eddy viscosities in the vertical and horizontal directions. An analytical solution of the problem is given in terms of Fourier series. The solution covers two special cases, gradually and continuously converging channels, for which a mechanism of formation of the surface circulation region is described. The method takes account of additional horizontal density changes in a reservoir. Those appear to have significant influence upon the extent of the region of circulation. The characteristic features of the flow pattern are circulation regions at the surface and bottom. Within those regions there exist internal closed eddies which cause vertical circulation of water in a density-stratified reservoir. A source of sequentially created internal eddies is the corner between the free water surface and the intake tower. (Moore-IVI)
W84-01483

10BE AND BE IN THE MAURICE RIVER-UNION LAKE SYSTEM OF SOUTHERN NEW JERSEY,
Rutgers - The State Univ., New Brunswick, NJ. Dept. of Chemistry.
L. Lundberg, T. Ticich, G. F. Herzog, T. Hughes, and G. Ashley.
Journal of Geophysical Research, Vol. 88, No. C7, p 4498-4504, May 20, 1983. 3 Fig, 1 Tab, 22 Ref.

Descriptors: *Beryllium, *Isotope studies, Lakes, Silicates, Organic matter, Isotopic tracers, Maurice River, Union Lake, New Jersey.

The Be10 and Be contents of 22 samples taken from seven locations in the Maurice River-Union Lake system of southern New Jersey are reported. Bulk Be10 contents range 0.05 to 2.7 dpm/kg and Be from <0.1 to 2 ppm. Silicate minerals separated from Union Lake sediments appear to have a constant surface concentration of about 500,000 atoms Be10/sq cm. Organic material is greatly enriched in Be: hand-picked samples contain over 10 dpm/kg of Be10 and 5 ppm of Be. The deposition rate of Be10 in Union Lake is about 1 atoms/sq cm s. (Author's abstract)
W84-01488

INTERBIOME COMPARISON OF STREAM ECOSYSTEM DYNAMICS,
Idaho State Univ., Pocatello. Dept. of Biology.
G. W. Minshall, R. C. Petersen, K. W. Cummins, T. L. Bott, and J. R. Sedell.
Ecological Monographs, Vol. 53, No. 1, p 1-25, 1983. 19 Fig, 10 Tab, 63 Ref.

Descriptors: *Ecosystems, *Streams, *Organic matter, Stream order, Productivity, Watersheds, Headwaters, Aquatic environment, Turnover time, Velocity, Decomposition, Leaf pack, Aquatic biota.

Studies were conducted in four distinct geographic areas (biomes/sites) in northern United States to examine changes in key ecosystems parameters; benthic organic matter (BOM), transported organic matter (TOM), community production and respiration, leaf pack decomposition, and functional feeding-group composition along gradients of increasing stream size. Four stations ranging from headwaters (1st or 2nd order) to midsized rivers (5th to 7th order) were examined at each site using comparable methods. The results for each parameter are presented and discussed in each site using comparable methods. The results for each parameter are presented and discussed in light of the River Continuum Concept of Vannote et al. (1980). The postulated gradual change in a stream ecosystem's structure and function is supported by this study. However, regional and local deviations occur as a result of variations in the influence of: (1) watershed climate and geology, (2) riparian conditions, (3) tributaries, and (4) location-specific lithology and geomorphology. In particular, the continuum framework must be visualized as a sliding scale which is shifted upstream or downstream depending on macroenvironmental forces (1 and 2) or reset following the application of more localized 'micro'-environmental influences (3 and 4). Analysis of interactions between BOM and TOM permitted evaluation of stream retentiveness for organic matter. Headwaters generally were most retentive and downstream reaches the least. Estimates of organic matter turnover times ranged between 0.2 and 14 yr, and commonly were 1-4 yr. Both turnover times and distances were determined primarily by the interaction between current velocity and stream retention. Biological processes played a secondary role. However, the streams varied considerably in their spiraling of organic matter due to differences in the interplay between retentiveness and biological activity. Differences in the relative importance of retention mechanisms along the continuum suggests that headwater stream ecosystems may be functionally more stable, at least to physical disturbances, than are their intermediate river counterparts. (Author's abstract)
W84-01644

POPULATION ECOLOGY OF NITRIFIERS IN A STREAM RECEIVING GEOTHERMAL INPUTS OF AMMONIUM,
Ministry of Works and Development, Hamilton (New Zealand). Water and Soil Science Centre.
A. B. Cooper.
Applied and Environmental Microbiology, Vol. 45, No. 4, p 1170-1177, April, 1983. 3 Fig, 4 Tab, 19 Ref.

Descriptors: *Nitrification, *Bacteria, *Ammonium, Geothermal water, Nitrates, Sediments, Oxygenation, Nitrosospira, Nitrosomomas.

The distribution, activity, and generic diversity of nitrifying bacteria in a stream receiving geothermal inputs of ammonium were studied. The high estimated rates of benthic nitrate flux (33 to 75 mg of N/sq m/h) were a result of the activity of nitrifiers located in the sediment. Nitrifying potentials and ammonium oxidizer most probable numbers in the sediments were at least one order of magnitude higher than those in the waters. Nitrifiers in the oxygenated surface (0 to 2 cm) sediments were limited by suboptimal temperature, pH, and substrate level. Nitrifiers in deep (nonsurface) oxygenated sediments did not contribute significantly to the changes measured in the levels of inorganic nitrogen species in the overlying waters and presumably derived their ammonium supply from ammonification within the sediment. Ammonium-oxidizing isolates obtained by a most probable number nonenrichment procedure were species of either Nitrosospira or Nitrosomonas, whereas all those obtained by an enrichment procedure (i.e., selective culture) were Nitrosomonas spp. The efficiency of the most-probable-number method for enumerating ammonium oxidizers was calculated to be between 0.05 and 2.0%, suggesting that measurements of nitrifying potentials provide a better estimate of nitrifying populations. (Author's abstract)
W84-01646

METHANOGENESIS FROM METHANOL AND METHYLAMINES AND ACETOGENESIS FROM HYDROGEN AND CARBON DIOXIDE IN THE SEDIMENTS OF A EUTROPHIC LAKE,
Michigan State Univ., Hickory Corners. W.K. Kellogg Biological Station.
D. R. Lovley, and M. J. Klug.
Applied and Environmental Microbiology, Vol. 45, No. 4, p 1310-1315, April, 1983. 1 Fig, 4 Tab, 21 Ref.

Descriptors: *Metabolism, *Methanogenesis, *Acetogenesis, *Sediments, Eutrophic lakes, Methanol, Methylamines, Carbon dioxide, Hydrogen, Acetates, Wintergreen Lake, Michigan.

Carbon-14 tracer techniques were used to examine the metabolism of methanol and methylamines and acetogenesis from hydrogen and carbon dioxide in sediments from the profundal and littoral zones of eutrophic Wintergreen Lake, Michigan. Methanogens were primarily responsible for the metabolism of methanol, monomethylamine, and trimethylamine and maintained the pool size of these substrates below 10 micro M in both sediment types. Methanol and methylamines were the precursors for less than 5 and 1%, respectively, of the total methane produced. Methanol and methylamines continued to be metabolized to methane when the sulfate concentration in the sediment was increased to 20mM. Less than 2% of the total acetate production was derived from carbon dioxide reduction. Hydrogen consumption by hydrogen-oxidizing acetogens was 5% or less of the total hydrogen uptake by acetogens and methanogens. These results, in conjunction with previous studies, emphasize that acetate and hydrogen are the major methane precursors and that methanogens are the predominant hydrogen consumers in the sediments of this eutrophic lake. (Author's abstract)
W84-01648

RADIOASSAY FOR HYDROGENASE ACTIVITY IN VIABLE CELLS AND DOCUMENTATION OF AEROBIC HYDROGEN-CONSUMING BACTERIA LIVING IN EXTREME ENVIRONMENTS,
Wisconsin Univ.-Madison. Dept. of Bacteriology.
B. Schink, F. S. Lupton, and J. G. Zeikus.

Applied and Environmental Microbiology, Vol. 45, No. 5, p 1491-1500, May, 1983. 10 Fig, 2 Tab, 32 Ref.

Descriptors: *Bacteria, *Hydrogenase, *Hydrogen metabolism, *Isotopic tracers, Saline water, Acid water, Thermal water, Aerobic conditions, Desulfovibrio, Clostridium, Methanosarcina, Natural waters, Extreme environments.

An isotopic tracer assay based on the hydrogenase-dependent formation of tritiated water from tritium gas was developed for in life analysis of microbial hydrogen transformation. This method allowed detection of bacterial hydrogen metabolism in pure cultures or in natural samples obtained from aquatic ecosystems. A differentiation between chemical-biological and aerobic-anaerobic hydrogen metabolism was established by variation of the experimental incubation temperature or by addition of selective inhibitors. Hydrogenase activity was shown to be proportional to the consumption or production of hydrogen by cultures of Desulfovibrio vulgaris, Clostridium pasteurianum, and Methanosarcina barkeri. The method was applied, in connection with measurements of free hydrogen and most-probable-number enumerations, in aerobic natural source waters to establish the activity and document the ecology of hydrogen-consuming bacteria in extreme acid, thermal, or saline environments. The utility of the assay is based in part on the ability to quantify bacterial hydrogen transformation at natural hydrogen partial pressures, without the use of artificial electron acceptors. (Author's abstract)
W84-01652

HYDROGEN METABOLISM BY DECOMPOSING CYANOBACTERIAL AGGREGATES IN BIG SODA LAKE, NEVADA,
Geological Survey, Menlo Park, CA.
R. S. Oremland.
Applied and Environmental Microbiology, Vol. 45, No. 5, p 1519-1525, May, 1983. 5 Fig, 2 Tab, 26 Ref.

Descriptors: *Hydrogen metabolism, *Cyanobacteria, Cyanophyta, Bacteria, Nitrogen fixation, Fermentation, Metabolism, Decomposition, Anaerobic conditions, Big Soda Lake, Nevada.

Hydrogen production by incubated cyanobacterial epiphytes occurred only in the dark, was stimulated by C2H2, and was inhibited by O2. Addition of NO3(-) inhibited dark, anaerobic H2 production, whereas the addition of NH4(+) inhibited N2 fixation (C2H2 reduction) but not dark H2 production. Aerobically incubated cyanobacterial aggregates consumed H2, but light-incubated rates (3.6 micromol of H2/g/h) were statistically equivalent to dark uptake rates (4.8 micromol of H2/g/h), which were statistically equivalent to dark, anaerobic production rates (2.5 to 10 micromol of H2/g/h). Production rates of H2 were fourfold higher for aggregates in a more advanced stage of decomposition. Enrichment cultures of H2-producing fermentative bacteria were recovered from freshly harvested, H2-producing cyanobacterial aggregates. Hydrogen production in these cyanobacterial communities appears to be caused by the resident bacterial flora and not by the cyanobacteria. In situ areal estimates of dark H2 production by submerged epiphytes (6.8 micromol of H2/sq m/h) were much lower than rates of light-driven N2 fixation by the epiphytic cyanobacteria (310 micromol of C2H4/sq m/h). (Author's abstract)
W84-01653

MICROBIOLOGICAL SURVEY OF ADIRONDACK LAKES WITH VARIOUS PH VALUES,
Rensselaer Polytechnic Inst., Troy, NY. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W84-01654

INITIAL EFFECTS OF THE MOUNT ST. HELENS ERUPTION ON NITROGEN CYCLE AND RELATED CHEMICAL PROCESSES IN RYAN LAKE,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
C. N. Dahm, J. A. Baross, A. K. Ward, M. D. Lilley, and J. R. Sedell.
Applied and Environmental Microbiology, Vol. 45, No. 5, p 1633-1645, May, 1983. 10 Fig, 6 Tab, 48 Ref.

Descriptors: *Mount St. Helens, *Volcanoes, *Nitrogen cycle, *Lakes, Nutrients, Cyanobacteria, Bacteria, Nutrient cycling, Phosphorus, Sulfur, Manganese, Iron, Organic carbon, Ryan Lake.

Ryan Lake, a 1.6-hectare basin lake near the periphery of the tree blowdown area in the blast zone 19 km north of Mount St. Helens, was studied from August to October 1980 to determine the microbial and chemical response of the lake to the eruption. Nutrient enrichment through the addition of fresh volcanic material and the organic debris from the surrounding conifer forest stimulated intense microbial activity. Concentrations of such nutrients as phosphorus, sulfur, manganese, iron, and dissolved organic carbon were markedly elevated. Nitrogen cycle activity was especially important to the lake ecosystem in regulating biogeochemical cycling owing to the limiting abundance of nitrogen compounds. Nitrogen fixation, both aerobic and anaerobic, was active from aerobic benthic and planktonic cyanobacteria with rates up to 210 nmol of N2/cm/h and 667 nmol of N2/l/h, respectively, and from anaerobic bacteria with rates reaching 220 nmol of N2/l/h. Nitrification was limited to the aerobic epilimnion and littoral zones where rates were 43 and 261 nmol of NO2/l/day, respectively. Potential denitrification rates were as high as 30 micromol of N2O/l/d in the anaerobic hypolimnion. Total bacterial numbers ranged from 1 x 10 to the 6th to 3 x 10 to the 8th power/ml with the number of viable sulfur-metal-oxidizing bacteria reaching 2,000,000/ml in the hypolimnion. A general scenario for the microbial cycling of nitrogen, carbon, sulfur, and metals is presented for volcanically impacted lakes. The important role of nitrogen as these lakes recover from the cataclysmic eruption and proceed back towards their prior status as oligotrophic alpine lakes is emphasized. (Author's abstract)
W84-01657

ESTIMATING BACTERIOPLANKTON PRODUCTION BY MEASURING (3H)THYMIDINE INCORPORATION IN A EUTROPHIC SWEDISH LAKE,
Uppsala Univ. (Sweden). Limnologiska Institutionen.
R. T. Bell, G. M. Ahlgren, and I. Ahlgren.
Applied and Environmental Microbiology, Vol. 45, No. 6, p 1709-1721, June, 1983. 2 Fig, 10 Tab, 77 Ref. Swedish National Science Research Council grant B-BU 3083-105.

Descriptors: *Bacteria, *Plankton, *Eutrophic lakes, *Thymidine, Primary productivity, Chrysophyta, Cyanophyta, Cyanobacteria, Biomass, Radioactive tracers, Carbon dioxide, Lake Norrviken, Sweden.

Bacterioplankton abundance, tritiated thymidine incorporation, carbon-14 labeled CO2 uptake in the dark, and fractionated primary production were measured on several occasions between June and August 1982 in eutrophic Lake Norrviken, Sweden. Bacterioplankton abundance and carbon biomass ranged from 0.5 x 10 to the 9th power to 2.4 x 10 to the 9th power cells/l and 7 to 47 micro g of C/l, respectively. The average bacterial cell volume was 0.185 cu micro m. Thymidine incorporation into cold-trichloroacetic acid-insoluble material ranged from 12 x 10 to the 12th power to 200 x 10 to the 12th power mol/l/h. Bacterial carbon production rates were estimated to be 0.2 to 7.1 micro g of C/l/h. Bacterial production estimates from thymidine incorporation and CO2 uptake in the dark agreed when activity was high but diverged when activity was low and when blue-green algae (cyanobacteria) dominated the phytoplankton. Size fractionation indicated negligible uptake of thymidine in the > 3 micro m fraction during a chrysophycean bloom in early June. More than 50% of the 3H activity was in the > 3 micro m fraction in late August; this phenomenon was most likely due to Microcystis spp., their associated bacteria, or both. Over 60% of the CO2 uptake in the dark was attributed to algae on each sampling occasion. Algal exudate was an important carbon source for planktonic bacteria. Bacterial production was roughly 50% of primary production. (Moore-IVI)
W84-01658

COMPARISON OF DENITRIFICATION RATE ESTIMATION TECHNIQUES IN A LARGE, SHALLOW LAKE,
Utah Water Research Lab., Logan.
J. Messer, and P. L. Brezonik.
Water Resources, Vol. 17, No. 6, p 631-640, June, 1983. 5 Fig, 5 Tab, 35 Ref.

Descriptors: *Denitrification, *Mass balance, *Bottle incubation, Model studies, Nitrates, Organic carbon, Suspended solids, Nitrogen input, Florida, Lake Okeechobee.

A comparison was made between various incubation techniques and a mass balance model for estimating annual denitrification rates in Lake Okeechobee, Florida, a large, shallow lake. Incubation techniques involving isolation of the sediment from nitrate and labile organic carbon sources tended to produce low rate estimates, while diagenetic models based on nitrate profiles tended to produce unrealistically high rate estimates. Each technique has inherent errors when used with frequently suspended sediments, but most incubation techniques were in general agreement with mass balance calculations. Denitrification rate estimates range from 0.5 to 1.3 g N/sq m/yr, which represents 9-23% of the average annual nitrogen inputs to the lake. (Author's abstract)
W84-01679

SURVEY OF STOCKING POLICIES FOR TAILWATER TROUT FISHERIES IN THE SOUTHERN UNITED STATES,
Fish and Wildlife Service, Bowling Green, KY. East Central Reservoir Investigations.
W. D. Swink.
Progressive Fish-Culturist, Vol. 45, No. 2, p 67-71, April, 1983. 3 Tab, 10 Ref.

Descriptors: *Trout, *Tailwater, *Fish stocking, Fisheries, Fingerlings, Fishing pressure.

A survey of the 16 southern states showed that 48 tailwaters in 13 states were stocked with trout in 1980. Of the almost 3.7 million trout released in these waters, 81% were of catchable size and 19% were fingerlings (< 150mm). Tailwaters received 32% of all trout stocked in the South; nearly 95% of the tailwater fish were rainbow trout (Salmo gairdneri). A trend away from 'put-grow-and-take' fisheries toward 'put-and-take' fisheries was noted. Limited creel data confirmed that fishing pressure in southern tailwaters was heavy, and that 25 to 90% of the trout stocked were recovered by anglers. (Author's abstract)
W84-01683

SENSITIVITY OF FLORIDA LAKES TO ACIDIC PRECIPITATION,
Florida Univ., Gainesville. School of Forest Resources and Conservation.
D. E. Canfield, Jr.
Water Resources Research, Vol. 19, No. 3, p 833-839, June, 1983. 3 Fig, 4 Tab, 66 Ref. Dept. of the Interior project 14-16-0009-79-064.

Descriptors: *Lakes, *Water chemistry, *Florida, Hydrogen ion concentration, Alkalinity, Calcite, Calcium, Hardness, Acid rain, Zooplankton, Chlorophyll a, Lake fisheries.

To assess the potential vulnerability of Florida lakes to damage by acidic precipitation, data from a survey of 165 lakes located in the major physiographic and geologic regions of Florida were used to determine pH, total alkalinity, calcium hardness, and calcite saturation index values. Mean lake pH ranged from 4.1 to 8.9. Mean total alkalinity concentrations ranged from 0 to 4100 ueq/l and mean

calcium hardness concentrations ranged from 20 to 4300 ueq/l. Total alkalinity averaged below 200 ueq/l in 49% of the sampled lakes. Calcite saturation index values were greater than 4 in 36% of the sampled lakes. Based on these data, Florida has a large number of lakes that are vulnerable to reductions in pH and alkalinity by acidic precipitation. Data on chlorophyll a concentrations, zooplankton abundance, and recent fisheries data, however, suggest that Florida lakes may not be as biologically sensitive as the alkalinity and calcite saturation indices might suggest. Low phosphorus and nitrogen concentrations are primarily responsible for reduced animal and plant populations in acidic Florida lakes. Consequently, predictions of future impacts or trends based on current sensitivity indices should be regarded with caution. (Author's abstract)
W84-01725

2I. Water In Plants

EFFECT OF SUMMER MOISTURE STRESS ON THE CAPACITY OF TANSY RAGWORT (SENECIO JACOBAEA) TO COMPENSATE FOR DEFOLIATION BY CINNABAR MOTH (TYRIA JACOBAEAE),
Oregon State Univ., Corvallis. Dept. of Entomology.
C. S. Cox, and P. B. McEvoy.
Journal of Applied Ecology, Vol. 20, No. 1, p 225-234, April, 1983. 3 Fig, 2 Tab, 20 Ref.

Descriptors: *Moisture stress, *Defoliation, Moisture availability, Ragwort, Rainfall, Weed control, Biological control.

Tansy ragwort plants were grown under different irrigation regimes to assess the effect of summer moisture stress on their capacity to compensate for defoliation by larvae of the cinnabar moth. Three measures of compensation capacity increased with increasing frequency of irrigation: the amount of growth produced following defoliation, the number of nodes which produced this growth, and the number of flower heads (capitula) produced following defoliation. Thus moisture availability limited plant compensation under these experimental conditions. Compensation capacity was positively correlated with moisture availability in (a) comparisons of populations at a high summer rainfall site and a low summer rainfall site and (b) comparisons of populations during wet and dry years. Thus moisture availability appeared to limit plant compensation under natural as well as experimental conditions. These results indicate that the full potential of the cinnabar moth as a biological control agent of tansy ragwort will be apparent in years with below average summer rainfall. In wet areas the introduction of additional biological control agents should be considered. Investigation of the influences of abiotic conditions on the interactions between plants and their herbivores may be necessary in other studies concerned with predicting the outcome of this interaction. (Author's abstract)
W84-01442

SNOW AS A FACTOR IN SALT DESERT SHRUB VEGETATION PATTERNS IN CURLEW VALLEY, UTAH,
N. E. West, and M. M. Caldwell.
American Midland Naturalist, Vol. 109, No. 2, p 376-379, April, 1983. 1 Tab, 9 Ref.

Descriptors: *Snow depths, *Desert plants, *Vegetation, Soil water, Shrubs, Snowpack, Wind, Melting, Sublimation, Utah.

Significant differences in average snow depths - for some dates in each of four winters - occurred at two locations each in pure Atriplex confertifolia and Ceratoides lanata stands and an intermediate mixed-species stand. The average depth of snow cover over the season that the snow lasted was significantly different between community types in two of the four winters investigated. Average snow depth in the Ceratoides type was less than in pure Atriplex and the mixed type. The difference were likely related to variations in stature of the vegetation which modify snow deposition, redistribution by wind, melting and sublimation. The difference in snow depth corresponded with greater soil moisture recharge under the taller vegetation for 1 year for which data were available. Occasional differential snowpack development in these adjacent communities may influence vegetation boundaries in this area. (Author's abstract)
W84-01451

SIMULATION MODEL OF THE WATER BALANCE OF A CROPPED SOIL: SWATRE,
Instituut voor Cultuurtechniek en Waterhuishouding, Wageningen (Netherlands).
For primary bibliographic entry see Field 2G.
W84-01694

2J. Erosion and Sedimentation

SEDIMENTATION IN A LARGE LAKE: A REINTERPRETATION OF THE LATE PLEISTOCENE STRATIGRAPHY AT SCARBOROUGH BLUFFS, ONTARIO, CANADA,
Toronto Univ. (Ontario). Dept. of Geology.
C. H. Eyles, and N. Eyles.
Geology, Vol. 11, No. 3, p 146-152, March, 1983. 4 Fig, 37 Ref.

Descriptors: *Sedimentation, *Lakes, Glacial drift, Suspended sediments, Pleistocene, Canada.

A lithofacies code developed for diamicts emphasizes facies variability in the classic upper Pleistocene glaciogenic sequence at Scarborough Bluffs, Ontario, Canada. Lithological breaks along the bluffs are traditionally assigned to incursions of grounded ice margins and to interstadial lakes formed during ice retreat, during the Early and Middle Wisconsin. Detailed sedimentological logging through three diamict units (previously formalized as Sunnybrook, Seminary, and Meadowcliffe Tills) are intervening sandy lithofacies shows absence of glaciotectonic structures and diamicts associated with grounded glacier ice, traction-current activity during diamict accumulation, postdepositional resedimentation of diamicts into topographic lows accompanied by turbidite acitivity, a subaqueous deltaic origin for intervening sandy lithofacies, and loaded, transitional, and interbedded contacts between sand and diamict. The Scarborough Bluffs sequence may be the preserved bottom stratigraphy of a large lake. The bottom stratigraphy results from repeated basinward progradation of deltaic sandy lithofacies over glaciolacustrine diamicts deposted below floating ice, whether ice shelf, ramp, bergs, or lake ice. A facies model is presented by glaciolacustrine diamict deposition on the floors of enlarged Pleistocene lakes trapping substantial volumes of fine-grained suspended sediment. (Author's abstract)
W84-01444

REMODIFIED EINSTEIN PROCEDURE FOR SEDIMENT LOAD,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
H. W. Shen, and C. S. Hung.
Journal of Hydraulic Engineering, Vol. 109, No. 4, p 565-578, April, 1983. 5 Fig, 3 Tab, 7 Ref. ENG 7825054.

Descriptors: *Sediment transport, Suspended sediments, Flow, Sampling, River flow, Mathematical studies.

A procedure has been developed to calculate the total sediment transport rates from the flow and suspended sediment data collected from the sampled zone (by depth integrated sampler). This procedure is a modification of the well-known 'Modified Einstein Procedure.' The two major modifications are that (1) The z components in the Modified Einstein Procedure, based on the 0.7 power of the fall velocity, were replaced with a regression equation to be determined by actual field data; and (2) an optimization procedure with constraints was included to minimize the difference between the measured and calculated suspended sediment rates in the sampled zone. Using measured loads from large rivers, a comparison of suspended sediment loads calculated by the two methods indicates that this Remodified Einstein Procedure is superior to the Modified Einstein Procedure. Results from this study also indicate that sediment load in unsampled zone for larger rivers can exceed the measured sediment load in sampled zones. (Author's abstract)
W84-01536

THE HYDRAULICS OF RESERVOIR SEDIMENTATION,
Ecole Polytechnique Federale de Lausanne (Switzerland). Lab. d'Hydraulique.
W. H. Graf.
International Water Power and Dam Construction, Vol. 35, No. 4, p 45-52, April, 1983. 12 Fig, 52 Ref.

Descriptors: *Reservoirs, *Sedimentation, *Hydraulics, Deposition, Mathematical studies, Deltas, Erosion, River flow.

Various theoretical approaches to the problem of reservoir sedimentation are considered along with empirical predictions of delta formation. Predicting the deposition pattern can only be done for conditions which simplify the model. If the geometry of the channel-reservoir system, the change in roughness, the non-uniformity of the sediment, the hydrograph of the watercourse, and the reservoir operation are all taken into account, a very complex model is obtained. Deltas are formed if the flow of the river diminishes in velocity and the coarse fractions of incoming sediments are deposited. Bottom sediment is formed downstream from deltas, when the finer fractions are deposited. Important criteria are the evaluation of the water surface profile, which will change once deposition occurs, and evaluation of the bottom (bed) profile which will alter as deposition progresses. For hydraulic calculations it is necessary to satisfy the continuity of water flow, continuity of sediment transport, and conservation of momentum of waterflow. It is also necessary to use a relationship for sediment transport (bedload and/or suspended load), and a relationship for flow resistance. In the Lehigh approach, the backwater profile is obtained in a river-reservoir system, without the sediment transport being considered, and then the deposition of the bedload is determined in successive short reaches along the system. This approach is rather simple, yielding the growth and the advancement of the delta formation, resembling the ones observed in a real situation. In the Grenoble approach the evolution of the longitudinal profile of a river and the transport of sediments on the river bed are simulated. The HEC approach is similar in point of view of hydraulics to the other approaches. The concept of the approach is such that continuous updating can and is done. Other methods include dimensional analysis, load distribution relationships, and comprehensive surveys of the mathematical techniques of solving the water and sediment equation. (Baker-IVI)
W84-01621

DISSOLVED IONS, STABLE AND RADIOACTIVE ISOTOPES AND NOBLE GASES IN THERMAL WATERS OF SOUTH AFRICA,
University of the Witwatersrand, Johannesburg (South Africa). Nuclear Physics Research Unit.
E. Mazor, and B. Th. Verhagen.
Journal of Hydrology, Vol. 63, No. 3-4, p 315-329, June, 1983. 3 Fig, 6 Tab, 22 Ref.

Descriptors: *Thermal springs, *South Africa, *Water chemistry, Isotopes, Groundwater recharge, Tritium, Neon, Argon, Krypton, Xenon, Water temperature, Helium, Geochemistry.

Sixteen thermal springs of South Africa were studied. Chemically, two salinity groups were found; one group at 3-13 meq/l TDI (total dissolved ions) issuing in crystalline terrains, and a more saline group, 30-80 meq/l TDI, mostly associated with sedimentary rocks. Stable hydrogen and oxygen isotopic compositions indicate direct recharge by heavy rains and negligible intermixing with water from adjacent rivers. Tritium concentrations are generally low. In a few cases, tritium at the limit of

detection, combined with sub-recent C14, might indicate some admixture of recent water. Dissolved Ne, Ar, Kr and Xe occur at atmospheric isotopic composition and at concentrations indicating intake temperatures of 15-35 degrees C. These intake temperatures show a clear dependence of climatic and geographical factors. Some of the springs contain significant amounts of radiogenic helium, accompanied by radiogenic argon. The (He4/Ar40) radiogenic values are in the range of 1-7, indicating common rocks as the origin rather than concentrates (ores) of U and Th. Low helium values in some of the thermal springs are explained by large flows and short residence times. (Author's abstract)
W84-01696

ONE-DIMENSIONAL BED WAVE MOVEMENT IN LOWLAND RIVERS,
Department of Scientific and Industrial Research, Wellington (New Zealand). Applied Mathematics Div.
G. J. Weir.
Water Resources Research, Vol. 19, No. 3, p 627-631, June, 1983. 2 Tab, 22 Ref.

Descriptors: *Gravel, *Bed wave, *Sediment transport, Friction, Bed load, River beds, Wyoming, East Fork River.

Large quantities of gravel may translate down a river in the form of a bed wave. The central difficulties in formulating a one-dimensional gravel flow theory are the uncertainties in the transport laws for gravel and for water friction. Bed form translational speeds and the apparent changes in channel cross-sectional area are independent of water friction, but bed form evolution is water friction dependent. Recent measurements in the East Fork River, Wyoming, of annual gravel wave translation, annual bedload transport, and annual variations in riverbed cross-sectional area can be described to within a factor of 2 by using the Gradowczyk characteristic velocity for bed waves to describe gravel wave translation, the Engelund-Hansen formula for bedload transport, and a DuBoyslike formula for changes in cross-sectional area. No free parameters are needed. (Moore-IVI)
W84-01705

VARIABILITY OF SEDIMENT REMOVAL IN A SEMIARID WATERSHED,
Arizona State Univ., Tempe. Dept. of Geography.
W. L. Graf.
Water Resources Research, Vol. 19, No. 3, p 643-652, June, 1983. 11 Fig, 1 Tab, 37 Ref. NSF grant EAR-7727698.

Descriptors: *Sediment erosion, *Semiarid lands, *Alluvium, Sediment transport, Channel morphology, Sediment storage, Stream order, Spatial distribution, Walnut Gulch Watershed, Arizona.

Field and documentary data from Walnut Gulch Watershed, an instrumented semiarid drainage basin of approximately 150 sq km (57 sq mi) in southeastern Arizona, show that 83% of the alluvium removed from the basin during a 15-year episode beginning about 1930 was excavated from the highest-order stream. The amount of alluvium removed in the erosion episode would have been equal to a covering of about 4 cm (1.6 in) over the entire basin. The rate of sediment removal during the erosion episode was 18 times greater than the rate of present channel sediment transport. Production of sediment from slopes and channel throughput as present rates are approximately equal, and refilling will not occur under present conditions. The channel forms left by the massive evacuation of sediment impose controls on the spatial distribution of tractive force and total stream power that make renewed storage of sediment likely in only a few restricted locations. Modern instrumented records of a decade or more provide an inadequate perspective on long-terms sediment movement. (Author's abstract)
W84-01707

PARTICULATE DYNAMICS, DISSOLVED AND TOTAL LOAD, IN TWO SMALL BASINS, NORTHERN PENNINES, UK,
Freshwater Biological Association, Ambleside (England).
P. A. Carling.
Hydrological Sciences Journal, Vol. 28, No. 3, p 355-375, September, 1983. 6 Fig, 5 Tab, 73 Ref.

Descriptors: *Suspended sediments, *Dissolved solids, Streamflow, Flashy streams, Cations, Precipitation, Storm runoff, Flow discharge, Hydrographs, Organic matter, Silt, Flood peak, Carl Beck, Great Eggleshope Beck, England.

Suspended sediment and dissolved load were measured in two upland piedmont gravel-bedded streams, Carl Beck and Great Eggleshope Beck, for one year. In addition, the input of major cations from precipitation and the cation content of springs within the basins were monitored. The dynamics of the suspended load through a series of storm flows were examined in relation to sediment supply and progressive exhaustion effects. In both Carl Beck and Great Eggleshope Beck suspended sediment concentration increased during storm periods with discharge. This increase was described by a second-order polynomial function with a tendency for the concentration to fall towards a constant suspended sediment concentration at baseflow of 3 mg/l. In each case, the load was an undercapacity load. The impact of sediment from collapsing stream banks, the variable timing of sediment concentration peaks in relation to the hydrograph peaks, and progressive sediment exhaustion effects reflect variable sediment supply. Nevertheless, in as much as storm discharge and concentration were correlated, hydraulic control of concentration level remained significant in these flashy streams. The organic concentration varied between 33 mg/l and less than 1 mg/l with an arithmetic mean of 4.8 mg/l. The concentration of the organic sediment increased as a power function of the total suspended sediment concentration. Most suspended inorganic material was coarse silt. Increases in mean grain size coincided with flood peaks when competancy was at a maximum and reflect the dominance of in-channel sediment sources. For Carl Beck, the total load for 1980 was calculated to be 135.38 t/sq km/year; for Great Eggleshope Beck, the total load was calculated to be 12.62 t/sq km/year. (Moore-IVI)
W84-01762

2K. Chemical Processes

SEASONAL VARIATION IN THE ACCUMULATION OF RADIONUCLIDES OF THE URANIUM SERIES BY YELLOW POND-LILY (NUPHAR LUTEA),
Simon Fraser Univ., Burnaby (British Columbia). Dept. of Biological Sciences.
D. C. Mahon, and R. W. Mathewes.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 5, p 575-581, May, 1983. 1 Fig, 5 Tab, 11 Ref.

*Water analysis, *Radioisotopes, *Seasonal variations, Chemical composition, Plants, Macrophytes, Accumulation, Aquatic plants, Heavy metals, Uranium, Radon, Biological magnification.

The potential for bioconcentration of naturally occurring radionuclides was investigated in yellow pond-lily and possible seasonal variations were also considered. Water, plant and lake sediment samples were collected from an area of high natural radioactivity in the Okanagan Highlands of south-central British Columbia. The water chemistry of the seven sample sites during both spring and summer showed increases in the dissolved U-nat content in the spring. There may have also been a slight variation in the concentration of Po-210, but it was not verified statistically. Both Ra-226 and Pb-210 stayed effectively below the limits of detection. Radionuclide concentrations in the sediments from each location did not differ significantly by season, though there were small changes, probably due to changes in the water table, surface run-off patterns and degree of saturation of the soil in the environs of the ore body. In autumn there was no correlation between the surface water pH and dissolved U-nat, but a higher negative correlation between surface water pH and sediment burden of U-nat existed. The data indicate that as the pH rises the aquatransport of U-nat decreases. U-nat apparently moves from the ore body in the spring and is accumulated in the sediments during the summer. A significant seasonality was noted in the accumulation of U-nat and Ra-226 by the aquatic macrophyte Nuphar lutea. This suggests the mechanism of accumulation is independent of the common external factors associated with the accumulation of heavy metal residues such as water concentration or pH. The differences are thus probably due to changes in the physiological state of the plant. These data identify the critical natures of the sample collection time in the investigation of heavy metal accumulation or transport in aquatic systems. (Baker-IVI)
W84-01436

MEASUREMENT OF WEAK ORGANIC ACIDITY IN PRECIPITATION FROM REMOTE AREAS OF THE WORLD,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
W. C. Keene, J. N. Galloway, and J. D. Holden, Jr.
Journal of Geophysical Research, Vol. 88, No. C9, p 5122-5130, June 20, 1983. 7 Fig, 5 Tab, 26 Ref.

Descriptors: *Chemistry of precipitation, *Acids, Acid rain, Ions, Organic acid, Formic acid, Acetic acid, Australia.

The Global Precipitation Chemistry Project collects precipitation by event to determine the composition of precipitation and processes that control it in five remote regions. Ion balances based on major inorganic species revealed consistent anion deficits at certain sites. This and other evidence suggested that weak organic acids contributed to free acidity. Accurate and precise techniques were developed to measure organic anions and total acidity in precipitation. Twelve samples from a remote site were analyzed for major organic and inorganic chemical constituents. Formic and acetic acids were found in all aliquots which had been treated with a biocide. The disappearance of these acids from untreated aliquots corresponded to a proportionate decrease in free acidity. Weak organic acids contributed 64% of free acidity and 63% of total acidity to precipitation during part of the 1981-1982 wet season at Katherine, Australia. Unmeasured proton donors contributed 21% of total acidity during the period. (Author's abstract)
W84-01489

TEMPORAL DISTRIBUTIONS OF RADIOSTRONTIUM ISOTOPES AND RADON DAUGHTERS IN RAINWATER DURING A THUNDERSTORM,
L. A. Burchfield, J. D. Akridge, and P. K. Kuroda.
Journal of Geophysical Research, Vol. 88, No. C13, p 8579-8584, October 20, 1983. 3 Fig, 2 Tab, 18 Ref. ATM 78-19965.

Descriptors: *Rainwater, *Isotope studies, Strontium, Lead, Polonium, Cesium, Thunderstorms, Air masses, Arkansas.

The concentrations of Sr89, Sr90, Cs137, Pb210, Pb212, and Po210 were measured in sequentially sampled rainwater during a thunderstorm occurring at Fayetteville, Arkansas, on January 29, 1981. Approximately concordant mean residence times ranging from 43 to 136 days were obtained from the observed ratios of Sr89/Sr90 and Po210/Pb210. The Pb212/Pb210 ratio was found to correlate negatively with the Po210/Pb210 ratio. The variation of the Pb212/Pb210 ratio appeared to have resulted from turbulent mixing of air masses, and it increased sharply after the rainfall reached a peak value. (Author's abstract)
W84-01491

AQUEOUS GEOCHEMISTRY AND THE EXCHANGEABLE CATION COMPOSITION OF GLAUCONITE IN THE AQUIA AQUIFER, MARYLAND,

Geological Survey, Towson, MD.
F. H. Chapelle, and L. L. Knobel.
Ground Water, Vol. 21, No. 3, p 343-352, May-June, 1983, 6 Fig, 1 Tab, 15 Ref.

Descriptors: *Water chemistry, *Aquifers, *Groundwater movement, Cation exchange, Calcium, Magnesium, Potassium, Sodium, Glauconite, Silica, Dissolved oxygen, Aquia aquifer, Maryland.

The cation composition of water in the Aquia aquifer of southern Maryland changes systematically in the direction of ground-water flow. In the upgradient parts of the aquifer, calcium is the dominant cation in solution. Between 10 and 20 mi downgradient, calcium and magnesium are dominant. Between 20 and 35 mi downgradient, magnesium and potassium are dominant, and, beyond 40 mi downgradient, sodium is the most abundant cation in solution. The exchangeable cation composition of glauconite in the Aquia aquifer changes systematically in the direction of flow in a manner similar to the changes in water chemistry. These observations are interpreted as evidence that cation exchange reactions are processes that simultaneously alter water composition and glauconite composition along the flowpath. Exchange parameters K' and n for glauconite in the Aquia aquifer were determined, and the exchange parameters for each reaction were tested by an indirect method. Molar ratios of exchangeable cations on glauconite were calculated from water chemistry data using the derived K' and n values. The sum of exchangable cations on glauconite samples is significantly lower in the outcrop area than downgradient. Corresponding to this, the concentration of dissolved silica and dissolved oxygen in Aquia water is high near the outcrop area and decreases downgradient. This pattern suggests that incongruent dissolution of glauconite is an additional process that modifies glauconite composition near the outcrop area but is less important downgradient. (Moore-IVI)
W84-01555

COMPLEXATION ANALYSIS OF FRESH WATERS BY EQUILIBRIUM DIAFILTRATION,
Geological Survey of Canada, Ottawa (Ontario). Resource Geophysics and Geochemistry Div.
J. Lee.
Water Resources, Vol. 17, No. 5, p 501-510, May, 1983. 3 Fig, 4 Tab, 32 Ref.

Descriptors: *Ultrafiltration, *Metal complexes, Copper, Nickel, Cobalt, Iron, Manganese, Zinc, Mineralization, Diafiltration, Hydrogen ion concentration, Organic compounds.

Equilibrium ultrafiltration has been employed to determine the extent of Cu, Ni, Co, Fe, Mn and Zn chelation in oxic waters from mineralized terrains. Concentrations of Cu, Ni and Co were determined in different organic fractions separated by various Amicon ultrafilters. Titrations of fresh water samples with metal ions were made, and 'free' metal concentration measured by equilibrium diafiltration. Experiments were made at concentrations and pH at which metals and ligands occur in natural waters. Conditional stability functions ranged from 10 to the 6.72nd power at pH 6.5 to 10 to the 7.07th power at pH 7.6 for Ni and 10 to the 8.85th power at pH 6.8 to 10 to the 6.97th at pH 7.6 for Co. At low metal concentrations (approximately 8 x 10 to the -7 M) only one complexing class of major importance for natural water environments was observed. The order of metal complexing ability was found to be Cu > Ni > Co > Zn > Mn with Cu showing a preference towards the higher MW organic fractions. (Author's abstract)
W84-01671

INVESTIGATION OF THE FOLIN-CIOCALTEAU PHENOL REAGENT FOR THE DETERMINATION OF POLYPHENOLIC SUBSTANCES IN NATURAL WATERS,
Freshwater Biological Association, Ambleside (England).
J. D. Box.
Water Resources, Vol. 17, No. 5, p 511-525, May, 1983. 7 Fig, 10 Tab, 43 Ref.

Descriptors: *Phenols, *Water analysis, *Natural waters, Tannin, Tannic acid, Fulvic acid, Tyrosine, Organic compounds, Iron hydroxide.

The methodology associated with the Folin-Ciocalteau phenol reagent was investigated and the performance characteristics of a method using sodium carbonate as the supporting medium were determined. Calibration curves using phenol, tannic acid, or L-tyrosine were linear up to at least 1000 micrograms/l. The limit of detection was 6 micrograms phenol/l and the relative standard deviation at 100 micrograms phenol/l was 5.2% and at 1000 micrograms phenol/l was 4.1%. The absorbances obtained with equal amounts of a range of potential standards showed variations when compared with that of phenol: phenol (100%). L-tyrosine (62%), oak gall tannin (58%), tannic acid (48%), chestnut tannin (26%), oak tannin (24%), fulvic acid (5%). The method was applicable to a wide range of monohydric and polyhydric phenolic substances and interferences from inorganic and non-phenolic organic compounds were examined. Interference would be expected above 30 micrograms S(2-)/l, 300 micrograms Mn(II)/l, or 400 micrograms SO3(2-)/l. Concentrations of iron > 2 mg/l as Fe(II) or Fe(III) formed the insoluble iron (III) hydroxide which increased the absorbance, but centrifugation could be used to remove this source of interference. Other potential sources of interference (e.g. reducing agents and certain metabolic products) would be expected to have a negligible effect in unpolluted waters. Methods using diazotized sulfanilic acid or 4-aminoantipyrine (4-AAP) were found to be inferior when applied to natural water samples. (Author's abstract)
W84-01672

CALCITE SUPERSATURATION AND PRECIPITATION KINETICS IN THE LOWER COLORADO RIVER, ALL-AMERICAN CANAL AND EAST HIGHLINE CANAL,
Agricultural Research Service, Riverside, CA. Salinity Lab.
D. L. Suarez.
Water Resources Research, Vol. 19, No. 3, p 653-661, June, 1983. 8 Fig, 20 Ref.

Descriptors: *Calcite, *Supersaturation, *Colorado River, Chemical precipitation, Return flows, Saline water, Calcium carbonate, Residence time, Suspended load, Algae, Seasonal variation, Diurnal distribution, Chemical kinetics, All-American Canal, East Highline Canal.

In situ pH determinations and analysis of major ions in solution indicated that the lower Colorado River is supersaturated with respect to calcite throughout the entire daily cycle, in both winter and summer. Although the ion activity product was 4 to 6 times greater than the calcite solubility product, there was no detectable precipitation. Chemical analyses of water samples taken along 350 km of the river and canals from Parker Dam to the Salton Sea also revealed no evidence of calcium carbonate precipitation despite the inflow of saline and highly supersaturated irrigation return flows. Laboratory kinetic studies indicated that calcite crystal growth rates with Colorado River water are about 30% of the rate for pure Ca-HCO3 waters and about 70% of that for synethic Colorado River water. Calcite precipitation by crystal growth in the river is limited by the combination of short residence times and unavailability of reactive calcite. Critical supersaturation levels necessary for heterogeneous nucleation do not occur; a high suspended load limits algal photosynthesis and thus prevents large decreases in daytime H2CO3 levels. (Author's abstract)
W84-01708

KINETIC ANALYSIS OF STRONTIUM AND POTASSIUM SORPTION ONTO SANDS AND GRAVELS IN A NATURAL CHANNEL,
Geological Survey, Menlo Park, CA.
K. E. Bencala, A. P. Jackman, V. C. Kennedy, R. J. Avanzino, and G. W. Zellweger.
Water Resources Research, Vol. 19, No. 3, p 725-731, June, 1983. 9 Fig, 2 Tab, 19 Ref.

Descriptors: *Sorption, *Mass transfer, *Strontium, *Kinetics, *Potassium, Sand, Gravel, Mathematical models, Particle size, Mountain streams, Uvas Creek, California.

A kinetic, first-order mass transfer model was used to describe the sorption of strontium onto sand-and gravel-sized streambed sediments. Rate parameters, empirically determined for strontium, allowed for the prediction of potassium sorption with moderate success. The model parameters varied significantly with particle size. The sorption data were collected during an experimental injection of several elements into Uvas Creek, a small mountain pool-and-riffle stream on the Eastern slope of the Santa Cruz Mountains in California. The processes simulated are expected to also occur in much larger high-gradient streams. The sorption process onto sand-and gravel-sized sediment was relatively slow compared to changes in the dissolved concentrations. Although the model is empirical, qualitative interpretations can be given to the physical significance of the model and their size-dependent trends. (Moore-IVI)
W84-01715

SIMULATION OF SOLUTE TRANSPORT IN A MOUNTAIN POOL-AND-RIFFLE STREAM WITH A KINETIC MASS TRANSFER MODEL FOR SORPTION,
Geological Survey, Menlo Park, CA.
K. E. Bencala.
Water Resources Research, Vol. 19, No. 3, p 732-738, June, 1983. 7 Fig, 2 Tab, 21 Ref.

Descriptors: *Solute transport, *Mass transfer, *Sorption, Simulation, Streambeds, Mathematical models, Strontium, Kinetics, Pools, Riffles, Mountain streams, Hydrodynamics.

In natural channels there are often long periods of low flow during which solutes have repeated opportunity for contact with relatively immobile bed materials. Such conditions can exist in very small pool-and-riffle mountain streams. If a solute can sorb onto bed materials, then both hydrodynamics and chemical processes control solute transport. A simulation of these processes is presented for a carefully controlled and intensively monitored strontium injection experiment. The numerical model couples nonreactive, transient storage with a kinetic mass transport model for sorption. The results are compared to both in-stream and on-sediment strontium measurements. In mountain streams the stream hydrology is complex and is governed by a wide variety of time and distance scales. The present simulations assist in interpreting the relative roles of hydrologic and sorptive kinetic processes, and indicate the practical limits of our process and parameter knowledge. The simulations are relatively insensitive to the details of the kinetic mechanisms and to the spatial variability of the stream parameters. (Author's abstract)
W84-01716

SUPPLY-BASED MODELS OF SUSPENDED SEDIMENT TRANSPORT IN STREAMS,
Oregon State Univ., Corvallis. Dept. of Forest Engineering.
J. VanSickle, and R. L. Beschta.
Water Resources Research, Vol. 19, No. 3, p 768-778, June, 1983. 9 Fig, 1 Tab, 29 Ref.

Descriptors: *Sediment transport, *Suspended sediments, *Mathematical models, Sediment storage, Streamflow, Storm runoff, Reservoir releases, Flynn Creek Watershed, Oregon, Electric Lake Reservoir, Utah.

Most of the uncertainty in empirical streamflow-sediment relationships can be attributed to changing supplies. The transport model utilizes a power function which was augmented with a variable S representing sediment storage in the channel system. The resulting supply-based model was calibrated to concentration and streamflow time series data from four storm events in Flynn Creek watershed, a small forested watershed in coastal Oregon. The model was calibrated to data from a controlled release from Electric Lake Reservoir in Utah, during which streamflow was held constant for an extended period. The supply-based model

followed observed concentration time series more accurately than did a transport model based on S alone. Performance of the supply-based model was further enhanced by distributing sediment supplies S among several compartments which were accessed at different levels of stream discharge. Both the single-compartment and distributed models demonstrate that a knowledge of sediment supplies can improve predictions of suspended sediment concentrations during storm runoff. (Moore-IVI)
W84-01720

2L. Estuaries

SEASONAL DIVERSITY, ABUNDANCE, AND DISTRIBUTION OF ICHTHYOPLANKTON IN TAMIAHUA LAGOON, WESTERN GULF OF MEXICO,
Universidad Nacional Autonoma de Mexico, Mexico City. Centro de Ciencias del Mar y Limnologia.
C. Flores-Coto, F. Barba-Torres, and J. Sanchez-Robles.
Transactions of the American Fisheries Society, Vol. 112, No. 2B, p 247-256, March, 1983. 5 Fig, 2 Tab, 31 Ref.

Descriptors: *Plankton, *Lagoons, *Fish, Larvae, Salinity, Water temperature, Seasonal variation, Species diversity, Tamiahua Lagoon, Mexico.

The ichthyoplanktonic community of Tamiahua Lagoon, Veracruz, Mexico, was studied throughout an annual cycle. Major concentrations of larvae occurred in the central portion of the lagoon, occasionally along the channels, but never at the inlets. The cycle of larva abundance was correlated with cycles of salinity and temperature. In spite of the greater number of species then, the spring and summer periods had low species diversity and evenness, due to the marked domination by larvae of Anchoa mitchilli. The number of larval fish species and individuals entering the lagoon from the adjacent offshore waters was minimal. The greatest portion of species diversity is generated within the lagoon itself. The community structure identified corresponds to the physically controlled type, as indicated by the poor diversity values obtained. (Author's abstract)
W84-01404

SPATIAL DISTRIBUTION PATTERNS OF PLANKTONIC FISH EGGS IN LOWER MOBILE BAY, ALABAMA,
University of South Alabama, Mobile. Dept. of Biology.
R. D. Marley.
Transactions of the American Fisheries Society, Vol. 112, No. 2B, p 257-266, March, 1983. 8 Fig, 1 Tab, 26 Ref.

Descriptors: *Estuaries, *Fish eggs, *Spatial distribution, Salinity, River discharge, Spawning, Water circulation, Mobile Bay, Alabama.

A 12-month survey of planktonic fish eggs in lower Mobile Bay yielded 110 samples containing over 105 eggs. Fourteen taxa were represented, of which eight were abundant enough for analysis. By normal and inverse schemes of numerical classification, two distinct assemblages (station groups), coastal and estuarine, were found. The coastal assemblage was influenced by high-salinity tidal intrusions, whereas the estuarine assemblage was influenced by low-salinity estuarine water and river discharge. The spawning location of adult fish, circulation patterns, and salinity gradients (due to river discharge) were responsible for delineating the two assemblages. There also were two species associations (species groups). Eggs of Anchoa mitchilli, Sciaenidae, and Symphurus sp. were ubiquitous in both the estuarine and coastal assemblages. The eggs of Harengula jaguana, Anchoa hepsetus, Anchoa sp., Chloroscombrus chrysurus, and Trinectes maculatus were found predominantly in the coastal assemblage. Month-to-month differences in the spatial distribution of eggs reflected the magnitude of river discharge into the estuary. All fish eggs were confined to bottom waters during high river discharge, but were about equally divided between surface and bottom waters when river discharge was low. (Author's abstract)
W84-01405

THE EFFECT OF NITROGEN FERTILIZATION ON THE PRODUCTION OF HALOPHYTES IN AN INLAND SALT MARSH,
Ohio Univ., Athens. Dept. of Botany.
D. G. Loveland, and I. A. Ungar.
American Midland Naturalist, Vol. 109, No. 2, p 346-354, April, 1983. 5 Fig, 2 Tab, 31 Ref. DEB 79-27236.

Descriptors: *Salt marshes, *Nitrogen, *Marsh plants, Halophytes, Productivity, Nutrients, Fertilization, Ohio.

The effect of nitrogen fertilization on plant production, soil and plant nitrogen content, and species distribution in an Ohio salt marsh was analyzed. Seasonal measurements indicate that the three dominant species attained maximal production at different times during the growing season. Production of Salicornia europaea increased with nitrogen fertilization and it appears that reduced soil nitrogen concentrations may be responsible for the different growth forms of S. europaea found in this marsh. Shoot nitrogen concentrations of S. europaea were inversely related to the growth response to fertilization. High tissue nitrogen concentrations in Hordeum jubatum and Atriplex triangularis suggest that some factor other than nitrogen is limiting to these species. (Author's abstract)
W84-01450

EFFECTS OF PERMANENT FLOODING ON CAREX-EQUISETUM WETLANDS IN NORTHERN SWEDEN,
Sveriges Lantbruksuniversitet, Umea. Dept. of Wildlife Ecology.
K. Sjoberg, and K. Danell.
Aquatic Botany, Vol. 15, No. 3, p 275-286, March, 1983. 3 Fig, 4 Tab, 33 Ref.

Descriptors: *Wetlands, *Flooding, *Vegetation, Water depth, Wildlife habitats, Marsh management, Sweden.

The effect of flooding sites of former, periodically flooded water-meadows in northern Sweden was studied in two areas for two and three years, respectively. The vegetation consisted mainly of Equisetum fluviatile L., Carex rostrata Stokes, Carex aquatilis Wahlenb., Comarum palustre L., and Lysimachia thyrsiflora L. Increase in water depth caused a significant decrease in the species number. Carex rostrata, C. aquatilis and Lysimachia thyrsiflora were almost eliminated (although Carex aquatilis seemed to be somewhat more tolerant to the increased water depth). Equisetum fluviatile was unaffected, except for increase in shoot length, while the effect of flooding on Comarum palustre was intermediate. The practical application of flooding is discussed with regard to habitat management for waterfowl. (Author's abstract)
W84-01452

THE RESPONSE OF INTERSTITIAL AMMONIUM IN EELGRASS (ZOSTERA MARINA L.) BEDS TO ENVIRONMENTAL PERTURBATIONS,
Harbor Branch Foundation, Inc., Fort Pierce, FL.
F. T. Short.
Journal of Experimental Marine Biology and Ecology, Vol. 68, No. 2, p 195-208, April, 1983. 7 Fig, 2 Tab, 26 Ref. OCR-74-13457A02, OCE-77-27050.

Descriptors: *Eelgrass, *Marine sediments, *Ammonium, Seagrasses, Nitrogen uptake, Scour, Substrates, Nutrients.

Natural and human-induced perturbations of eelgrass (Zostera marina L.) beds were used to examine the interaction between the sediment interstitial ammonium pool and nitrogen uptake by the plants. The perturbations included: a natural destruction of an eelgrass bed by ice damage (scouring), followed by recolonization by eelgrass; colonization of introduced foreign substratum by eelgrass; leaf removal; and sealing the sediment surface. Eelgrass colonization of unvegetated areas was accompanied by a substantial decrease in the interstitial ammonium pool over a 4-yr period. The changes in interstitial ammonium and shoot density during colonization support an already determined relationship between shoot density and ammonium pool measurements. In field perturbation experiments, removing eelgrass leaves and sealing the sediment surface altered the flux of ammonium from the interstitial ammonium pool, and resulted in a rapid increase in interstitial ammonium concentrations. Measurements of ammonium accumulation under the various perturbation conditions and a control permitted calculation of the sediment ammonium flux. These estimates include uptake by eelgrass roots, regeneration in the root zone, and diffusion from the sediments. Nitrogen limitation was observed in some eelgrass beds. (Moore-IVI)
W84-01478

A TWO-DIMENSIONAL NUMERICAL MODEL OF ESTUARINE CIRCULATION USING CUBIC SPLINES,
Ecole Polytechnique, Montreal (Quebec). Dept. of Civil Engineering.
P. Wang, and R. Kahawita.
Canadian Journal of Civil Engineering, Vol. 10, No. 1, p 116-124, March, 1983. 9 Fig, 11 Ref.

Descriptors: *Estuaries, *Mathematical models, *Water circulation, Velocity, Salinity, Simulation, Density stratification, Tidal effects, Hydraulic models, Cubic splines, Great Whale Bay.

A two-dimensional, laterally integrated, numerical model has been developed to represent the velocity and salinity distribution along an estuary. The governing equations, which express the conservation of mass, momentum, and salt or heat content, are solved by a finite difference method in combination with spline functions. The model has been applied to the estuary of the Great Whale River in the James Bay region and results of the simulation are presented and compared with tide gauge data. The sensitivity of the model to various values of the stratification parameters that influence vertical diffusion has been studied and some preliminary results presented. The use of the cubic spline formulation in computational hydraulics has been found to be promising and warrants further development. (Author's abstract)
W84-01510

THE HYDROGRAPHY AND PHYTOPLANKTON ECOLOGY OF LOCH ARDBHAIR: A SMALL SEA-LOCH ON THE WEST COAST OF SCOTLAND,
Dunstaffnage Marine Research Lab., Oban (Scotland).
R. J. Gowen, P. Tett, and K. J. Jones.
Journal of Experimental, Marine Biology and Ecology, Vol. 71, No. 1, p 1-16, August, 1983. 5 Fig, 7 Tab, 30 Ref.

Descriptors: *Lochs, *Tidal exchange, *Phytoplankton, *Hydrography, Eutrophication, Seasonal variation, Chlorophyll, Dinoflagellates, Diatoms, Flagellates, Species composition, Biomass, Fish farming, Estuarine environment, Loch Ardbhair, Eddrachillis Bay, Scotland.

Loch Ardbhair was studied between January 1981 and July 1982. Tidal exchange was the dominant hydrographic feature of the loch and the exchange time was estimated to be between 1 and 2 days. In 1981 seasonal changes in phytoplankton biomass and species succession were similar to other sea-lochs, although the spring peak, and summer levels of, phytoplankton biomass (3.0 and 1.0 mg chlorophyll/cu m respectively) were lower than might have been predicted from winter levels of nitrate. Chlorophyll levels in Ardbhair were much higher in July 1982 (up to 3.5 mg/cu m) compared to July 1981 (0.7 mg/cu m) and the phytoplankton was dominated by dinoflagellates rather than microflagellates and diatoms. Rapid exchange may limit in situ growth of phytoplankton in Ardbhair. Phytoplankton biomass and species composition in Ardb-

hair closely resembles that of Eddrachillis Bay with which the loch exchanges. Because of rapid exchange, phytoplankton blooms are unlikely to develop within such lochs. Lochs whose source water derives from frontal regions could be at risk from blooms of phytoplankton which might be harmful to farmed fish. (Moore-IVI)
W84-01643

CHARACTERISTICS OF ESCHERICHIA COLI GROWN IN BAY WATER AS COMPARED WITH RICH MEDIUM,
Maryland Univ., Cambridge. Center for Environmental and Estuarine Studies.
T. J. Chai.
Applied and Environmental Microbiology, Vol. 45, No. 4, p 1316-1323, April, 1983. 2 Fig, 7 Tab, 38 Ref.

Descriptors: *Escherichia coli, *Bay water, Bacteria, Antimicrobial agents, Heavy metals, Bacteriophages, Colicins, Detergents, Growth medium.

Membrane-filtered bay water can support a certain degree of growth of Escherichia coli organisms isolated from the bay water or from sewage. The effect of the growth medium (bay water versus rich medium) on sensitivities to antimicrobial agents and cell envelope proteins was studied in many of these strains. Bay water-grown cells were less sensitive to bacteriophages and colicins, but were more sensitive to heavy metals and detergents as compared with rich-medium-grown cells. These results indicated that the cell envelope composition of the bay water-grown cells could be modified, resulting in altered susceptibility to various antimicrobial agents. An analysis of cell envelope proteins by sodium dodecyl sulfate-polyarylamide gel electrophoresis revealed that cells from rich-medium-grown cultures contained two or three major outer membrane proteins, whereas in bay water-grown cells, the OmpF protein was greatly reduced. (Author's abstract)
W84-01649

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3B. Water Yield Improvement

REVERSING THE FLOW OF SOVIET RIVERS.
International Water Power and Dam Construction, Vol. 35, No. 5, p 53-57, May, 1983. 4 Fig, 49 Ref.

Descriptors: *Water resources development, *Water supply development, *Reservoirs, Water shortages, Water demand, Rivers, Environmental effects, USSR, Onega River, Sukhona River, Lake Onega, Rybinsk Reservoir, Volga River, Tobol River, Irtysh River, Novosibirsk Reservoir, Ob River, Chulym River, Tom River.

Proposals are being considered in the Soviet Union for transferring waters from northward flowing rivers to the south. Territorial redistribution of water resources in the USSR has become a matter of national policy. One of the two major plans being considered calls for diversion of waters from the Sukhona and Onega rivers and Lake Onega (possibly also from Lakes Lacha and Vozhe) into the Rybinsk reservoir and then to the upper reaches of the Volga. About 31 cu km a year would be withdrawn by 1990. Later stages of the plan envisage additional withdrawals variously from the Severnaya Dvina, Vychegda, Pinega, Mezen and Yug as well as from the basin of Lake Ladoga. The second plan differs primarily in the degree of probable impact on the environment. The first plan would involve drawing water from a reservoir to be built at the confluence of the Tobol and Irtysh and lifting it about 75 m, passing it through the Turgay Gate into Kazakhstan, after which it would flow by gravity towards the Aral region. In the second stage, water would be drawn from a reservoir in the Khanty-Mansiysk area and be transferred either by a special canal or along the bed of the Irtysh. In the second variant the main difference is that in the first stage use would be made of the existing Novosibirsk reservoir on the Ob, and it would involve transferring the water by a canal starting at Kamen-on-Ob which would cross the Kulunda Steppe to a proposed reservoir on the Irtysh above Pavlodar, then by canal to Kurgan and on south. The second stage envisages drawing water from the Chulym and Tom rivers, transferring it to a reservoir to be built on the Irtysh and then on to Kurgan. Yet a third plan combined features from the other two, withdrawing water from the Novosibirsk reservoir and the Irtysh and Tobol in the first stage, and from the Chulym and Tom in addition to these in the second stage. Other water transport projects include the Irtysh-Karaganda canal, the Ob-Kulunda canal and the Volga-Ural canal. Impacts on the environment include changes in the levels of the Caspian and Aral Seas. (Baker-IVI)
W84-01622

FOUND WATER AT 200 GALLONS/YARD.
American City and County, Vol. 98, No. 8, p 58-59, August, 1983. 3 Fig.

Descriptors: *Dredging, *Reservoirs, *Sludge lagoons, Portsmouth, Virginia, Lake Meade, Water storage, Sediments, Dredging.

A 4.0 billion gallon impoundment system serves about 120,000 people in Portsmouth and parts of Suffolk and Chesapeake, Virginia. Daming of the Nansemond River in the later 1950s to form Lake Meade blocked the natural dispersion of sedimentation from the water treatment plant. Sludge began to collect in the Lake, gradually reducing its useful capacity. Several methods for removing the sludge were contemplated. The method chosen called for use of a shallow-draft dredge moved by conventional over-the-road flatbed trailer. Removal rates ranged up to 2,000 GPM and up to 120 cu yd/hr during the dredging operation. The slurry flowed by gravity to the 250,000 gallon holding tank until it could be pumped to the city's sludge treatment lagoon. Dredging operations continued for 10 hours a day, six days a week. In 80 calendar days the work was completed. Over 30,000 cu yd of material had been removed. For every yard of material removed, 200 gallons of water capacity were gained. (Baker-IVI)
W84-01669

RAINWATER INFILTRATION INTO A BARE LOAMY SAND,
Central Arid Zone Research Inst., Jodhpur (India).
For primary bibliographic entry see Field 2G.
W84-01765

3C. Use Of Water Of Impaired Quality

WATER REUSE IN WATER SURPLUS ENVIRONMENT,
Memphis State Univ., TN.
J. W. Smith, and C. Ritter.
Journal of Water Resources Planning and Management, Vol. 109, No. 3, p 223-235, July, 1983. 7 Fig, 8 Tab, 2 Ref.

Descriptors: *Water reuse, *Water substitution, Cost analysis, Computers, Industrial water, Water use, Water allocation.

Water reuse or substitution for high quality water in a water surplus area can be economical and a long-term protection against shortages and land subsidence. Cost optimization using computer assisted analysis of use allocation between users ('sinks') and supply ('sources') demonstrated a viable analysis procedure as well as the potential for water substitution. Secondary water use by industry is more attractive in an urban environment than irrigation or ground water recharge and may best be suited for industrial parks or complexes where a dual system (process and domestic) can be installed. (Author's abstract)
W84-01463

RECLAMATION OF WASTEWATER CONSTITUENTS BY ION EXCHANGE; PART I REVIEW OF FLOWSHEETS FOR THE PROCESSES - CONTINUED FROM VOLUME 23 NUMBERS 1, 2 AND 4,
For primary bibliographic entry see Field 5D.
W84-01572

WASTEWATER REUSE AND RECYCLE IN PETROLEUM REFINERIES,
JRB Associates, Inc., Paramus, NJ.
B. S. Langer.
Chemical Engineering Progress, Vol. 79, No. 5, p 67-76, May, 1983. 1 Fig, 9 Tab.

Descriptors: *Water reuse, *Wastewater treatment, Reclaimed water, Petroleum industry, Wastewater renovation, Water use, Water supply development, Industrial wastes, Cooling towers.

Wastewater reuse and recycling techniques were studied at 15 petroleum refineries. Three of the refineries were selected for their exemplary reuse and recycle techniques, and the technologies used were investigated for their applicability at the remaining 12 facilities. Feasible reuse and recycle techniques were identified to reduce wastewater discharge and estimates of the associated costs were considered. Boiler feed waters involve large volumes of water, of which an estimated 37% is lost to the sewer in various forms, such as clean and scour condensate, boiler blowdown, and pretreatment wastes such as filter backwash, clarifier sludge, and softening regenerant. Steam condensate and vent loss elimination are also areas for considerable savings. Condensate recovery is the most economically attractive reduction technique studied. At refineries using cooling towers, the cooling tower blowdown streams amounted to one-third of the total refinery process wastewaters. Some refineries rely on air cooling to supply 20 to 40% of their cooling needs by Btu. Most refineries tend to pay insufficient attention to cooling water systems management. Some modifications which may be commonly applied include recycling cooling water from pumps, compressors and sample boxes that use blowdown; replacing existing oil-leaking pump gland packing with mechanical seals to permit collection and recycle of blowdown to cooling tower; reducing use of pump gland cooling water where pressure overused or eliminate service completely; and upgrade maintenance of existing systems to reduce leakage and sump overflow. Of the 12 refineries studied, potential areas for additional reuse of treated effluent were found at eight, for which possible flow reduction alternatives were identified. An average of 45% of the total process generated wastewaters could be reused for various purposes after end-of-pipe treatment at ten of the twelve refineries. (Baker-IVI)
W84-01664

IMPROVED EVAPORATORS FOR RADIOACTIVE WASTES,
Graver Co., Union, NJ. Unitech Div.
For primary bibliographic entry see Field 5D.
W84-01665

3E. Conservation In Industry

WATER CONSERVATION AND REUSE AT COAL-FIRED POWER PLANTS,
Burns and McDonnell, Kansas City, MO.
F. L. Shorney.
Journal of Water Resources Planning and Management, Vol. 109, No. 4, p 345-359, October, 1983. 2 Fig, 8 Tab, 2 Ref.

Descriptors: *Water conservation, *Water reuse, Power plants, Cooling water, Wastewater renovation, Wastewater treatment, Water requirements, Water treatment, Wastewater disposal.

Water conservation and reuse concepts which have been used at several major power plants (200 MW or larger) in the southwest, southeast, west, and mid-west United States are described. These plants typically employ wet-type cooling towers and most use wet-type, closed-loop sulfur dioxide

absorbers. All plants have limited discharge or zero liquid discharge site requirements. Basic concepts include the on-site storage of raw water and wastewater for operating flexibility, the treatment of raw water to optimize water use, water conservation in mechanical systems to minimize blowdown or waste streams, direct wastewater reuse and indirect reuse with wastewater treatment to reduce raw water requirements and site discharges, and water management to control the overall plant water balance. (Author's abstract)
W84-01470

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

EFFECTS OF PESTICIDES ON PURE AND MIXED SPECIES CULTURES OF SALT MARSH POOL ALGAE,
Northeastern Univ., Boston, MA. Dept. of Biology.
M. Maly, and E. Ruber.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 1, p 464-472, April, 1983. 6 Tab, 9 Ref. RR07143.

*Algal growth, *Pesticides, Carbaryl, Salt marshes, Tidal marshes, Marshes, Diatoms, Chlorophyta, Dinoflagellates, Water pollution effects.

The general sensitivity of three diatom species, Nitzchia closterium, Amphora coffeaformis v. borealis, and Amphiprora sp.; green alga, Chlorococcum sp.; and a dinoflagellate, Gonyzulax sp., to five pesticides (temephos, propoxur, chlorpyrifos, malathion, and carbaryl) was investigated. Carbaryl was the most generally toxic of the five insecticides tested, and was used for further studies. Amphiprora was the most broadly sensitive alga followed by Chlorococcum. Gonyaulax, resistant to a concentration of 10 ppm, was the least affected of the species. Amphiprora had lowered growth with concentrations of 10, 21 and 1 ppm, but the effect on growth lasted only 4 hr with 2 and 1 ppm. Amphora was slightly more sensitive than the other species with growth depressed by 10, 2, and 1 ppm and this effect persisted through the entire 96 hr test period. Growth of Chlorococcum was depressed for 96 hr at 10, 2, and 1 ppm of carbaryl. In comparing results from single to multispecies cultures experiments, it becomes apparent that one cannot predict the effect of carbaryl on components of multispecies cultures solely from its effects in single-species cultures. All four species are inhibited by carbaryl at 2 ppm in single-species culture but in multispecies cultures only two are inhibited. Also, the rank order of species sensitivity differs between the two experimental designs. Amphiprora is more sensitive in the multispecies communities and Chlorococcum in single species cultures. Similarly, results after 2 and 4 day tests are not necessarily good indicators of longer term outcomes. (Baker-IVI)
W84-01429

RESERVOIR OPERATION BY LINEAR AND DYNAMIC PROGRAMMING,
California Univ., Davis.
M. A. Marino, and B. Mohammadi.
Journal of Water Resources Planning and Management, Vol. 109, No. 4, p 303-319, October, 1983. 6 Fig, 4 Tab, 14 Ref. CAD-LAW-4116-H.

Descriptors: *Reservoir operation, *Computers, Water demand, Flow, Forecasting, Computer models, Mathematical models.

The operation of reservoirs often requires frequent updating of the results of the operation model. This is mainly because of errors involved in forecasting the natural inflows to the reservoirs or demands for water and energy or both. Current models used for operation usually require the use of large computers because of their core-storage and computation-time requirements. Frequent use of such models for the purpose of updating will often result in high computation cost and usually involves long turnaround times. An efficient algorithm is presented for the monthly operation of a system of two parallel multipurpose reservoirs that is solved with a minicomputer. The operation model is applied to Shasta and Folsom reservoirs of the California Central Valley Project. The formulation of the mathematical model itself allows for optimization of both municipal and industrial water and energy. While the addition of other objectives will increase the size of the dynamic programming, and will require more core storage, the addition of more reservoirs will not affect the dynamic programming but causes the linear programming size to increase linearly. (Moore-IVI)
W84-01467

TUNISIA'S BOURGUIBA DAM AIDS REGIONAL DEVELOPMENT.
International Water Power and Dam Construction, Vol. 35, No. 8, p 30-32, August, 1983. 3 Fig.

Descriptors: *Water resources development, *Dam construction, Tunisia, Bourguiba Dam, Environmental effects, Sidi Saad project, Saddle dam, Irrigation, Spillways.

The Bourguiba Dam in Tunisia was built at Sidi Saad on the Zeroud wadi to control the flash floods that have threatened the regions's central plain and the city of Kairouan. The water in the reservoir will recharge water tables and irrigate 4000 ha of land. The Zeroud wadi drains a basin of 8572 sq km that encompasses the southeastern slopes of the Dorsale range and the eastern tip of the Atlas range. The Merguellil wade drains a basin of 1140 sq km and flows directly to Kairouan across the central plain. The Sidi Saad project began in 1976. In 1980 Tunisia began a reforestation scheme which will continue for 15 years. The central element of the Sidi Saad project is a main dam, 70 m high and 560 m long, with its crest at elevation 302.5, built at the narrowest part of the Zeroud gorge 2 km upstream from the point where the wadi enters the plain. It is an earthfill dam with an impervious clay core, and with its upstream and downstream coffer dams, called for 4,438,000 cu m of fill material. The shells are made up mainly of silts and clays and the transition and filter zones of granular materials. A 100 m band of clay marl on the left bank extends into the river bed and reappears on the right bank, so the core material was placed downstream of it, and a grout curtain, reaching as deep as 100 m in places was injected into the foundation to make sure that the marl would remain impervious and that no water could seep under the dam. A saddle dam, 48 m high and 520 m long with its crest at elevation 302.5 closes the gorge on the right bank. An open concrete spillway with a capacity of 6900 cu m/sec is built in an 80 m deep cut through the right bank mountain between the two dams. The two dams create a reservoir with a capacity of 1,994,000 cu m. A desilting system, integrated with the temporary diversion tunnel, is working well and efficiently on the density current principle. (Baker-IVI)
W84-01634

WHY NOT CHARGE FOR STORM DRAINAGE,
P. Gallagher, and D. Laredo.
American City and County, Vol. 98, No. 5, p 45-46, May, 1983.

Descriptors: *Runoff, *Storm runoff, *Drainage, Storm drains, Storm wastewater, Land development.

Stormwater runoff is often increased due to residential and industrial land development. Local governments often try to deal with these problems through traditional methods of stormwater drainage facilities using ad valorem property tax funds. Tight municipal budgets are causing some communities to consider financing stormwater drainage systems through user charges and developer contributions. This necessitates viewing the stormwater drainage as a utility. Users of a drainage system are the properties adding stormwater runoff, while the beneficiaries are the properties protected from flooding. Users of stormwater drainage systems have a legal duty, although it is not as clearly recognized as the duty to provide wastewater treatment. The duty of land developers and property owners generally is to protect downstream properties from higher than natural runoff rates. A fiscally independent drainage utility generates both capital and operating funds from sources other than property taxes. A comprehensive basin-by-basin drainage plan should be prepared to guide near-term and long-term drainage system improvements. The master drainage plan should encompass not only the drainage basins within the local government's jurisdiction, but also basins or portions of basins that are outside the jurisdiction but affect drainage requirements within it. One primary advantage of utility-type financing, as opposed to traditional methods of financing, is the creation of a new revenue stream. Another advantage is the equity of recovering the costs of the service from those who use it. (Baker-IVI)
W84-01667

FOR A RELIABLE WATER SUPPLY, COST COMES SECOND.
American City and County, Vol. 98, No. 7, p 27-29, July, 1983. 3 Fig.

Descriptors: *Water supply development, *Pipelines, *Water conveyance, Drought, New Mexico, Raton, Water shortage, Economic aspects.

The town of Raton, New Mexico is situated in the high plains country in the northeast section of the state. The residents number about 8500 and the water shortage has been acute with recent droughts only reemphasizing the problem. Three sources of additional water were cited in 1975: major improvements to the T. O. Dam, a small impoundment on the Una de Gato Creek, about 12 mi southeast of Raton; a series of wells in the Capulin Basin some 26 mi southeast of the city; or a pipeline from the Cimarron River, 47 mi southwest of Raton. The last alternative was the one chosen as best. The system, as proposed, will be capable of supplying Raton with 2.5 MGD - adequate for a population of 13,000 or more. It begins with a new 2.5 million gallon reservoir at the existing water treatment plant. Upstream of this raw water reservoir are three pumping stations, each with its own 115,000 gallon bolted-steel reservoir. All four reservoirs and the pretreatment facilities are connected by a microcomputer-based UHF-radio system. The reservoir at the first station is filled by gravity flow from the diversion and pretreatment facilities 20 mi distant. If water is needed, it is released from Eagle Nest Lake into the Cimarron River. From the diversion structure on the river, a passive surface-water intake screen kept submerged by an automatic gate, water moves through a 2000-ft pipeline to the pretreatment facility. There it flows through a flocculator and clarifier basin equipped with tube settlers, which remove normal amounts of turbidity. If turbidity is above present limits, polymers are automatically added to increase removal rates. (Baker-IVI)
W84-01668

RESERVOIR MANAGEMENT: A RELIABILITY PROGRAMMING APPROACH,
California Univ., Davis. Dept. of Land, Air and Water Resources.
M. A. Marino, and B. Mahammadi.
Water Resources Research, Vol. 19, No. 3, p 613-620, June, 1983. 3 Fig, 3 Tab, 20 Ref. OWRT project A-088-CAL, WRC project UCAL-WRC-W-617.

Descriptors: *Reservoir operation, *Reservoir releases, *Computer programs, Flood protection, Drought, Reliability, Multipurpose reservoirs, Linear programming, Dynamic programming, Seasonal variation, California Central Valley Project, Folsom Reservoir.

A reliability programming model is developed to determine the optimum monthly releases from a multipurpose reservoir. The model is based on chance-constrained linear programming (CCLP) and dynamic programming (DP). The flood and

drought reliabilities are represented in the CCLP in the form of chance constraints. These reliabilities are varied parametrically from their minimum required levels to their maximum possible values. The trade-offs between flood and drought reliabilities are made using a forward two-dimensional DP routine. The model does not require equal flood and/or drought reliabilities during the year. Folsom reservoir of the California Central Valley Project is modeled to demonstrate the use of this reliability programming approach. The resulting operation policy shows high reliabilities of flood and drought during winter and summer months, respectively. The variable risk levels avoid unnecessary releases during summer (for flood protection) and unnecessary storage of water during winter (for drought protection). (Author's abstract)
W84-01703

4B. Groundwater Management

GROUND-WATER MANAGEMENT IN ARIZONA,
Arizona Dept. of Water Resources, Phoenix.
P. C. Briggs.
Journal of Water Resources Planning and Management, Vol. 109, No. 3, p 195-202, July, 1983. 4 Fig, 2 Ref.

Descriptors: *Groundwater management, *Legal aspects, *Arizona, Overdraft, Water rights, Safe yield, Water conservation, Economic aspects.

Arizona, which has had a long history of ground water overdraft, has recently adopted a Ground Water Code that is designed to not only restrict and control withdrawals and uses of ground water, but also to reduce rates of overdraft over time to attain safe yield conditions in three major management areas by the year 2025. The Code provides for ground water management by: (1) creating a system of rights for existing users, allowing the conveyance and transfer of rights to new users to meet the changing nature of the state's economy and permitting new rights to be issued only if the withdrawals will not excerbate the overdraft problem; (2) mandating all users to implement evermore stringent conservation measures that will be specified in a series of management plans; (3) providing for purchase and retirement of irrigated agricultural lands and rights; and (4) providing for augmentation and recharge projects. Implementation of the Code is proceeding; although statutorily mandated programs have been completed on time, as the Code's restrictions become more binding on the users, resistance among them is increasing. (Author's abstract)
W84-01461

ARIZONA'S WATER STRATEGY: BRING MORE IN AND RESTRICT ITS USE,
For primary bibliographic entry see Field 6D.
W84-01479

4C. Effects On Water Of Man's Non-Water Activities

HYDROLOGIC EFFECTS OF CLEARCUTTING AND WILDFIRE ON STEEP GRANITIC SLOPES IN IDAHO,
Intermountain Forest and Range Experiment Station, Boise, ID.
W. F. Megahan.
Water Resources Research, Vol. 19, No. 3, p 811-819, June, 1983. 9 Fig, 3 Tab, 23 Ref.

Descriptors: *Clear-cutting, *Wildfire, *Hydrologic properties, *Slopes, Logging, Inflow, Outflow, Water storage, Snowmelt, Evapotranspiration, Soil water, Erosion, Roads, Storm seepage, Interception, Channel erosion, Granite, Idaho.

Many of the environmental impacts of logging and wildfire are caused by changes in the hydrologic response of slopes after disturbances. This study was conducted to evaluate changes in inflow, storage, and outflow for 3-year periods before and after clearcut logging and wildfire on two steep, granitic microwatersheds in Idaho. Clearcutting alone and clearcutting plus wildfire increased annual peak snow water equivalent and snowmelt rates an average of 41% and 30%, respectively. The greater volume and rate of snowmelt caused respective increases in the peak piezometric rise and in total piezometric storage, amounting to 47% and 27%. Accordingly, the total volume of subsurface flow intercepted by the roadcut was increased 96% and was accompanied by 27% greater peak flow rates. None of the above responses were detectable on an adjacent watershed that was burned by wildfire alone. Evapotranspiration was reduced on both watersheds after clearcutting or wildfire, as indicated by increases in the unsaturated soil water content at the end of the growing season amounting to 44 and 72% respectively. Accelerated mass erosion on clearcut slopes, and accelerated surface and mass erosion on roads and in channels below roads, can result from such changes. (Author's abstract)
W84-01723

DESIGN OF CUT SLOPES IN OVERCONSOLIDATED CLAYS,
For primary bibliographic entry see Field 8D.
W84-01758

4D. Watershed Protection

SOIL EROSION: ECONOMIC AND TECHNOLOGICAL INTERFACES,
Department of Agriculture, Washington, DC.
G. S. Bridge.
Agricultural Engineering, Vol. 64, No. 8, p 13-16, August, 1983. 1 Fig, 2 Tab.

Descriptors: *Soil erosion, *Water conservation, *Regulations, Federal jurisdiction, Policy making, State jurisdiction.

Agriculture is the nation's biggest water user, accounting for about 50% of total freshwater withdrawals and over 80% of total consumption. While most of the country has enough surface water to meet demands most years, the High Plains area experiences the most extensive chronic water shortages. This is significant as considerable amounts of groundwater are being withdrawn for irrigation and other uses. In the High Plains, the increased cost of pumping water from greater depths is forcing many farmers to stop irrigating. Water pollution affects, to some degree, 95% of all US drainage basins. Non-point source pollution from agricultural lands is a major contributor to this problem. The USDA has developed a set of policies, priorities and initiatives to guide federal assistance activities for the next several years. Local and state governments will be encouraged to become full partners in developing and implementing conservation programs. (Baker-IVI)
W84-01611

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

AN IMPROVEMENT FOR THE CONCENTRATION OF MICROPOLLUTANTS IN THE MARINE ENVIRONMENT BY USING A BACTERIA STRAIN WITH A MEMBRANE FILTER SYSTEM,
System Science Consultants, Inc., Tokyo (Japan).
I. Allahpichay, M. Mishima, and T. Yoshida.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 3, p 253-260, March 1983. 5 Fig, 3 Tab, 13 Ref.

Descriptors: *Pollutant identification, Bacteria, Membrane filters, Filters, Marine environment, Biological magnification, DDT, Polychlorinated biphenyls.

Attempts were made to concentrate PCBs and DDT residues by a strain of bacteria and then to filter out the bacteria on a millipore filter using the model apparatus designed for this study. A Pseudomonas sp. was chosen as it represents one of the most dominant forms in the aquatic system. The selected strain demonstrated a bioconcentration ability in the range of 40-50% for PCBs and p,p-DDT in 3 hr exposures and attaining 80% for 12 hour exposures. The PCBs and DDT residues were not fully solubilized in the filtered seawater in spite of overnight stirring. The biofilter showed better recoveries than a membrane filter. There is a potential for PCBs and DDT residues in traces to be pre-concentrated using membrane filter and bacteria. Persistent pollutants adsorbed on to suspended particulates could be identified and quantified. Water samples assayed by this method showed traces of PCBs and p,p-DDE at concentrations sufficiently low that they were sensitive to the analytical method but could not be quantified, especially the PCBs. In trials of Tokyo Bay coastal waters, the p,-p-DDE adsorbed by the membrane filter-suspended particulates and the biofilter could be detected. This method could be used for evaluating the quality of water where PCBs and DDT residues could be present in concentrations below those toxic to aquatic life. (Baker-IVI)
W84-01418

DETECTION LIMITS OF A BIOLOGICAL MONITORING SYSTEM FOR CHEMICAL WATER POLLUTION BASED ON MUSSEL ACTIVITY,
Rijksinstituut voor Drinkwatervoorziening, Leidschendam (Netherlands). Chemical Biological Div.
W. Slooff, D. de Zwart, and J. M. Marquenie.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 1, p 400-405, April, 1983. 3 Tab, 15 Ref.

Descriptors: *Pollutant identification, *Monitoring, *Mussels, Mollusks, Organic compounds, Copper, Sulfates, Cadmium, Phenols, Cyanide, Industrial wastes.

An automatic early warning system for chemical water pollution is presented based on the valve response of the fresh water mussel, Dreissena polymorpha. To detect the behavior of mussels in terms of shell valve movements an electronic device was used. In this device one valve is fixed whereas the other valve transfers its action to a coil moving in an oscillating electromagnetic field generated by a fixed coil. The current in the receiving coil is subsequently converted to a voltage proportional to the valve displacement. The following chemicals resulted in a valve closure response: copper (sulfate), trichloroethylene, gamma-hexachlorocyclohexane, pentachlorophenol, hexachlorobutadiene, chloroform, ephnol, xylene, and cadmium (chloride). Although the biomonitor is probably somewhat less sensitive to toxicants than the system based on fish respiration, the mussel system is less susceptible to noise problems that may result in false alarms at an unacceptable rate. Changes in temperature and photoperiod do not interfere with the behavior of mussels. The mussel monitor is easier to handle as the replacement of the organisms takes less time, no individual control recordings are needed and feeding does not interrupt the measurements. Used in natural waters the mussels are self-maintaining. Hence, the mussel system is more feasible for wide-spread industrial applications that the fish respiration as it is more reliable and can be installed and operated at about 20% lower costs. (Baker-IVI)
W84-01423

USE OF FLUORESCENCE SPECTROSCOPY FOR MONITORING PETROLEUM HYDROCARBON CONTAMINATION IN ESTUARINE AND OCEAN WATERS,
Adelaide Univ. (Australia). Dept. of Physical and Inorganic Chemistry.
W. A. Maher.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 1, p 413-419, April, 1983. 2 Fig, 2 Tab, 9 Ref.

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5A—Identification Of Pollutants

Descriptors: *Monitoring, *Industrial wastes, *Fluorescence, Oil industry, Hydrocarbons, Organic compounds, Estuarine environment, Pollutant identification, Naphthalene.

Aromatic hydrocarbons were extracted from water samples after adjustment of pH to 4.0-5.0. The aromatic hydrocarbon content of the extracts was estimated by fluorescence emission spectroscopy. Solutions were excited at 300 nm, the emission scanned from 310-500 nm and the fluorescence emission intensity of the main peaks measured and reported as equivalents of m-terphenyl and chrysene. One liter samples of seawater were spiked with 1 microgram of either Tapis Bulai crude, Barrow Island crude or lubricating oil and analyzed by extraction and spectrofluorimetry. Recoveries of all oils were greater than 95%. Water samples were also collected from locations near potential sources of petroleum hydrocarbon inputs. The fluorescence emission intensity of extracts of 330 nm and 380 nm varied depending on the source of petroleum hydrocarbons. Measurement at 330 nm gave a better indication of petroleum discharges near the boat marine and sewerage inlet. Measurement at 330 nm and 380 was more suitable for monitoring potential inputs from oil refineries and storm water drains. The study showed that if fluorescence spectroscopy is to be used to monitor petroleum contamination of estuarine and sea waters, the fluorescence emission of extracts should be measured at least at two wavelengths to allow the detection of fuel oil, lubricating oil and crude oil inputs. Thus the measurement of the fluorescence emission of water extracts provides a rapid means of monitoring petroleum hydrocarbon contamination. (Baker-IVI)
W84-01425

X-RAY MICROANALYSIS OF PLANKTIC DIATOMS IN IN SITU STUDIES OF METAL POLLUTION,
Uppsala Univ. (Sweden). Inst. of Ecological Botany.
G. Lindahl, K. Wallstrom, G. M. Roomans, and M. Pedersen.
Botanica Marina, Vol. 26, No. 8, p 367-373, August, 1983. 5 Fig, 3 Tab, 13 Ref.

Descriptors: *Metals, *Diatoms, *X-ray spectroscopy, Microscopic anaylsis, Plankton, Heavy metals, Water pollution effects, Seasonal variation, Sweden.

X-ray microanalysis was applied to in situ studies of metal accumulation in plankton organisms, especially diatoms, in Skellefte Bay, a heavily polluted coastal area in northern Sweden. The metal load of the area is in the approximate order Fe>As>Mn>Zn>Cu>Pb>Cd. The metal accumulation in the plankton organisms was not proportional to the relative metal content in the water. Fe and Cu, which were most frequently accumulated, were found in connection to the silica frustules of the diatoms, probably as a result of ion exchange between the metals and the algae. Seasonal differences in the frequency of metal accumulation are most probably an effect of changes in the environmental conditions mainly due to variations in fresh water influence. Some unusual contaminants were found (such as Zr) which would probably have been missed by more conventional methods of analysis. The large variations within a single sample make the analysis of many cells necessary before representative values for the overall composition of the sample are obtained. Macroscopic comparisons between plankton samples are probably still best carried out by more conventional methods of analysis. X-ray microanalysis is, however, clearly a valuable tool in the interpretation of such comparisons. (Moore-IVI)
W84-01476

QUALITY CONTROL IN WATER ANALYSES,
Weston (Roy F.), Inc., West Chester, PA.
C. J. Kirchmer.
Environmental Science and Technology, Vol. 17, No. 4, p 174-186, April, 1983. 5 Fig, 1 Tab, 16 Ref.

Descriptors: *Water analysis, *Standards, Quality control, Testing procedures, Laboratories.

Although quality control has become an accepted and even required practice in water analysis labs, the definitions and principles underlying the practice of quality control still need to be critically evaluated. A distinction must be made between the errors of the analytical method and the errors of results. Great emphasis must be placed on specifying methods accurately and completely. There are six possible sources of bias or systematic error in water analyses: unrepresentative sampling, instability of samples between sampling and analysis, interference effects, biased calibration, a biased blank correction, and the inability to determine all forms of the determinand. A survey of standard methods and government approved methods of water analysis in the US indicates that the possibility of biased calibration curves or biased calibration factors resulting from the use of different analytical procedures for standards and samples is not widely recognized. Accurate analyses depend primarily on the implementation of a well conceived within the laboratory quality control program involving two stages: preliminary error estimation and routine quality control from the use of appropriate control charts. Between lab tests should involve two stages also: comparison of standard solutions used by each lab with a standard distributed by coordinating lab and the collaborative analysis of samples distributed to all labs by a coordinating lab. (Baker-IVI)
W84-01494

APPLICATION OF CONTINUOUS-FLOW ULTRAFILTRATION AND COMPETING LIGAND/DIFFERENTIAL SPECTROPHOTOMETRY FOR MEASUREMENT OF HEAVY METALS COMPLEXATION BY DISSOLVED ORGANIC MATTER,
Illinois State Water Survey Div., Champaign.
J. R. Tuschall, Jr., and P. L. Brezonik.
Analytica Chimica Acta, Vol. 149, p 47-58, May, 1983. 3 Fig, 2 Tab, 29 Ref. PFR-78-19199, EPA-R-806286020.

Descriptors: *Organic matter, *Heavy metals, *Metal complexes, Ultrafiltration, Spectrophotometry, Polyaspartic acid, Swamps, Copper, Metal binding.

Continuous ultrafiltration and competing ligand/differential spectrophotometric methods were developed to quantify metal complexation by naturally occurring aquatic organic matter. Results for copper(II) ion complexation by organic matter in two swamp waters and by a model compound (polyaspartic acid) were compared to values obtained by the established ion-selective electrode method. Copper(II) solution was added, and the parameters used to quantify complexation were the metal-binding capacity of the organic matter and conditional stability constant (beta') of the metal-organic complexes. Copper complexed strongly with the organic material at pH 6.25; beta' values ranged from 10(5.3) to 10(8.5). Values obtained with the three procedures compared well. (Author's abstract)
W84-01557

INTERFERENCES OF MAJOR ELEMENTS IN THE DETERMINATION OF LEAD, COPPER, CADMIUM, CHROMIUM AND NICKEL IN RIVER SEDIMENTS AND SEWAGE SLUDGES BY ELECTROTHERMAL ATOMIC ABSORPTION SPECTROMETRY (INTERFERENCES DES ELEMENTS MAJEURS SUR LA DETERMINATION DE PB, CU, CD, CR ET NI DANS LES SEDIMENTS DE COURS D'EAU ET LES BOUES DE STATIONS D'EPURATION PAR SPECTROMETRIE D'ABSORPTION ATOMIQUE SANS FLAMME),
Laboratoire Central des Ponts et Chaussees, Paris (France).
M. Legret, D. Demare, P. Marchandise, and D. Robbe.
Analytica Chimica Acta, Vol. 149, p 107-114, May, 1983. 1 Fig, 6 Tab, 10 Ref. English summary.

Descriptors: *Sediments, *Spectrometry, *Sludge, *Heavy metals, Interference, Metals, Lead, Copper, Cadmium, Chromium, Nickel.

The interferences of major elements of river sediments and sewage sludges (Fe, Al, Mg, Ca, Na, K, Ti and P) in the determination of Pb, Cu, Cd, Cr and Ni by electrothermal atomic absorption spectrometry are studied and the concentration ranges found in these environments are specified. Lead, cadmium and chromium were subject to the most interferences. (Author's abstract)
W84-01558

ZONE TRAPPING IN FLOW INJECTION ANALYSIS; SPECTROPHOTOMETRIC DETERMINATION OF LOW LEVELS OF AMMONIUM ION IN NATURAL WATERS,
Centro de Energia Nuclear na Agricultura, Piracicaba (Brazil).
F. J. Krug, B. F. Reis, M. F. Gine, E. A. G. Zagatto, and J. R. Ferreira.
Analytica Chimica Acta, Vol. 151, p 39-48, 1983. 3 Fig, 1 Tab, 17 Ref.

Descriptors: *Ammonium, *Flow injection analysis, *Spectrophotometry, Water analysis, Zone trapping, Metals, Interference.

In flow injection analysis, selected portion of a processed sample zone can be removed and, after a predetermined period of time reintroduced into the same carrier stream. This zone-trapped technique, easily applied, is suitable for methods based on relatively slow chemical reactions in which sensitivity or sampling rate is critical. It has some advantages over the stopped-flow and intermittent-flow approached. The technique was studied for a model system without chemical reaction, and was then applied in a sensitive spectrophotometric method for the determination of ammonium ion in natural waters, based on a modified Berthelot reaction. In zone trapping, the main portion of the reacting sample zone is retained in a 38 C water bath so that about 80% complete reaction is achieved without limiting the sampling rate. The proposed method is suitable for 90-100 measurements per hour with a relative standard deviation of 0.5% for a typical sample (0.15 mg/l ammonium). Beer's law is followed up to 1 mg/l and the detection limit is 5 micro g/l. Interferences of metals are overcome with EDTA. The results for waters agree well with those obtained by a standard manual procedure. (Author's abstract)
W84-01559

AN ELECTROMIGRATION METHOD FOR STUDYING TECHNETIUM IN GROUND WATER UNDER OXIC AND ANOXIC CONDITIONS,
Commission of the European Communities, Ispra (Italy). Joint Research Centre.
A. Chatt, G. Bidoglio, and A. DePlano.
Analytica Chimica Acta, Vol. 151, p 203-210, 1983. 1 Fig, 2 Tab, 16 Ref.

Descriptors: *Technetium, *Electromigration, Groundwater, Water analysis, Anoxic conditions, Diffusion coefficient.

A free-liquid electromigration method is described for studying the occurrence of technetium in ground water. Cells made of pyrex glass, teflon and plexiglass were examined for adsorption, diffusion, and electro-osmotic effects. Of the three cells designed, the pyrex glass cell is not recommended for use. The teflon cell can be particularly useful in situations where adsorption of reduced species in the cell is suspected. The plexiglass cell can reliably employed to determine mobility values under both oxic and anoxic conditions. Average mobilities of 0.000538 in oxic conditions and 0.000515 sq cm/s/V in anoxic conditions were obtained for the pertechnetate ion in ground water (ionic strength 0.003 M) at 24 C. The effective diffusion coefficient of this ion was calculated as 0.0000137 sq cm/s for oxic conditions. (Moore-IVI)
W84-01560

THE RAPID DETERMINATION OF ALGAL CHLOROPHYLL AND CAROTENOID PIGMENTS AND THEIR BREAKDOWN PRODUCTS IN NATURAL WATERS BY REVERSE-

PHASE HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY,
Institute for Marine Environmental Research, Plymouth (England).
R. F. C. Mantoura, and C. A. Llewellyn.
Analytica Chimica Acta, Vol. 151, No. 2, p 297-314, August, 1983. 8 Fig, 3 Tab, 35 Ref.

Descriptors: *Chromatography, *Chlorophyll, *Carotenoids, Algae, Pigments, Chlorophyllides, Phaeophorbides, High-performance liquid chromatography.

A reverse-phase high-performance liquid chromatographic (h.p.l.c.) system is developed for a rapid (about 20 min) separation and quantification of fourteen chlorophylls and their breakdown products and seventeen carotenoids from acetone extracts of algal cultures and natural waters. An ion-pairing reagent is included to achieve good resolution with the acidic chloropigments (chlorophyllides and phaeophorbides). Fluorescence and absorbance detectors are used to quantify chloropigments and carotenoids respectively, with detection limits of 0.01-0.2 ng for these pigments and 200-600 ng for carotenoids. Chlorophyll a at concentrations of 0.1 ng/l may be detected in sea water. Methanol is shown to be unsuitable for extracting pigments because it causes allomerization and transesterification of chlorophyll pigments in samples containing breakdown products grossly overestimates the actual concentration of these pigments, as determined by h.p.l.c. (Author's abstract)
W84-01561

DEVELOPMENT OF A NOVEL METHOD FOR MONITORING OILS IN WATER,
Environmental Monitoring and Support Lab.-Cincinnati, OH.
F. K. Kawahara, R. A. Fiutem, H. S. Silvus, F. M. Newman, and J. H. Frazar.
Analytica Chimica Acta, Vol. 151, p 315-327, 1983. 1 Fig, 6 Tab, 10 Ref. R 805817-01.

Descriptors: *Hydrocarbons, *Monitoring, Oil pollution, Lasers, Optical fibers, Aromatic compounds, Organophilic compounds.

A monitor for hydrocarbons in water is described. An unclad optical fiber, inserted through a stainless steel capillary, is coated with an organophilic compound such as octadecyltrichlorosilane. The input radiation is at 632.8 nm from a low-power laser. The normal total internal reflection is degraded by adsorption of hydrocarbons in the organophilic coating, because of the change in refractive index at the surface of the optical fiber, and the variation in output signal can be related to the concentration of hydrocarbon in the water flowing through the capillary. Aromatics, crude oil, and oil products dispersed in water can be measured directly, without solvent extraction. In its present form, the monitor can detect diesel oil in water at 17 mg/l and crude oil at 3 mg/l. Moreover, a relationship appears to exist between the solubility of a hydrocarbon and the detection threshold of the monitoring system. With the proper organophilic coating, the use of an optical fiber with a suitable detector will be promising for detection and measurement of such contaminants and, possibly, for specific types. (Author's abstract)
W84-01562

RAPID SEPARATION BY FLOTATION OF SUSPENDED SOLIDS IN FRESH WATERS FOR THE DETERMINATION OF ADSORBED HEAVY METALS,
Nagoya Univ. (Japan). Faculty of Engineering.
M. Hiraide, J. Mizutani, and A. Mizuike.
Analytica Chimica Acta, Vol. 151, p 329-337, 1983. 2 Fig, 5 Tab, 10 Ref.

Descriptors: *Heavy metals, *Suspended solids, *Flotation, Adsorption, Ultrasound, Atomic absorption spectrometry, Wastewater analysis, Water analysis.

Microgram or nanogram quantities of heavy metals adsorbed on suspended solids are selectively floated to the solution surface by bubbling for 15 s. Prior to the flotation, negatively charged suspended solids are rendered hydrophobic and coagulated by stirring with a cationic surfactant and sodium chloride. Metal ions, humic acid complexes and colloidal hydrated metal oxides are not floated at all. After the separation of the suspended solids, the trace heavy metals are desorbed by ultrasound in 4 M nitric acid and determined by electrothermal atomic absorption spectrometry. This rapid and convenient flotation technique is successfully applied to the analysis of river, pond and waste waters. (Author's abstract)
W84-01563

IDENTIFICATION OF A MEMBRANE FOULANT IN THE ELECTRODIALYTIC RECOVERY OF NICKEL,
Ford Motor Co., Dearborn, MI. Engineering and Research Staff.
For primary bibliographic entry see Field 5B.
W84-01577

DETERMINATION OF PHOSPHORUS IN NATURAL WATERS BY LONG-CAPILLARY-CELL ABSORPTION SPECTROMETRY,
Tokyo Univ. (Japan). Dept. of Chemistry.
W. Lei, K. Fujiwara, and K. Fuwa.
Analytical Chemistry, Vol. 55, No. 6, p 951-955, May, 1983. 4 Fig, 6 Tab, 13 Ref.

Descriptors: *Colorimetry, *Phosphorus, Water analysis, Sea water, Natural waters, Lake Katsumigaura, Japan.

Use of a long capillary cell (LCC) effectively enhances the detection power of ordinary colorimetry. The minimum necessary volume of sample is about 1-3 mL. By application of this method to molybdenum-blue colorimetry, 5 pg/mL of phosphorus is detectable. Phosphorus concentrations less than 1 ng/mL in seawater and lake water are successfully determined by using LCC. LCC produced good coincidence with values obtained for ordinary colorimetry in studies on phosphorus concentrations in Lake Kasumigaura (Japan). The advantages of LCC are low cost of construction, simple manipulation, and high stability of obtained signal. Although the use of the present system is limited to the visible region due to poor internal reflection of LCC at shorter wavelengths, the method is extensively applicable in colorimetry. (Moore-IVI)
W84-01578

DETERMINATION OF TRIALKYLLEAD COMPOUNDS IN WATER BY EXTRACTION AND GRAPHITE FURNACE ATOMIC ABSORPTION SPECTROMETRY,
Antwerp Univ., Wilrijk (Belgium). Dept. of Chemistry.
W. R. A. De Jonghe, W. E. Van Mol, and F. C. Adams.
Analytical Chemistry, Vol. 55, No. 7, p 1050-1054, June, 1983. 5 Fig, 6 Tab, 34 Ref.

Descriptors: *Trialkyllead compounds, *Atomic absorption spectrometry, Lead compounds, Water pollution, Light, Extraction.

A simple extraction procedure is described for the sensitive determination of traces of trialkyllead compounds in water. After enrichment of the sample by a fast vacuum distillation technique and saturation of the residual volume with sodium chloride, the analytes are extracted in chloroform. By incorporation of specific purification steps, interference from other forms of organic and inorganic lead is completely eliminated. The final chloroform extract is treated with a sulfuric acid solution in order to transfer the trialkyllead compounds present back into an aqueous solution. The analysis is completed by graphite furnace atomic absorption spectrometry. Under normal laboratory conditions, a detection limit of 0.02 micro g can be achieved with 1-L samples. The method was developed to investigate the occurrence of trialkyllead compounds in environmental water samples. Experiments with spiked lake water have established that there is a considerable loss of initially added triethyllead chloride upon exposure to sunlight, while trimethyllead remains fairly stable. (Author's abstract)
W84-01579

DETERMINATION OF ARSENIC AND PHOSPHORUS COMPOUNDS IN GROUNDWATER WITH REDUCED MOLYBDENUM BLUE,
Wisconsin Univ.-Madison. Water Chemistry Lab.
R. E. Stauffer.
Analytical Chemistry, Vol. 55, No. 8, p 1205-1210, July, 1983. 2 Fig, 4 Tab, 30 Ref. R805281010.

Descriptors: *Arsenic, *Phosphorus, *Colorimetry, Molybdenum blue, Groundwater, Water analysis, Arsenic compounds, Phosphorus compounds, Silica, Interference, Fluoride.

Chemical studies were made to optimize reduced molybdenum blue for arsenic and phosphorus determinations in chemically diverse groundwaters. Phosphate strongly catalyzes the development of the arsenic(V) molybdate complex; Increasing H(+) or H(+):Mo retards complexation, but the effect is greater for the potentially interfering silicomolybdate complex. The oxidation of As(III) to As(V) by iodate partially inhibits the subsequent color development of silica. Iodide has no effect. Fluoride ion partially suppresses silica color development, probably because of competetive Si-F complexing at low pH. The molybdate responses of As(V), P, and SiO2 mixtures are not color additive. Optimum reaction conditions are H(+) = 0.30 N; H(+):Mo = 88 for arsenic and phosphorus determinations in the presence of silica. Silica is an important analytical interference for the lower H(+) and H(+);Mo conditions recommended by several popular procedures. (Author's abstract)
W84-01580

CATION-EXCHANGE CONCENTRATION OF BASIC ORGANIC COMPOUNDS FROM AQUEOUS SOLUTION,
Ames Lab., IA.
J. R. Kaczvinsky, Jr., K. Saltoh, and J. S. Fritz.
Analytical Chemistry, Vol. 55, No. 8, p 1210-1215, July, 1983. 2 Fig, 3 Tab, 33 Ref. CHE-7906108.

Descriptors: *Cation-exchange resin, *Organic compounds, Water analysis, Wastewater analysis, Gas chromatography.

A macroreticular poly(styrene-divinylbenzene) cation-exchange resin is prepared. An aqueous sample is passed through a column of this resin in the H(+) form and organic bases are taken up as cations. Washings with methanol and ethyl ether remove sorbed neutral and acidic compounds. Ammonia gas is introduced into the column prior to elution of the basic organics with either methanol or ethyl ether containing ammonia. The eluate is concentrated by evaporation, and the concentrated sample is analyzed by gas chromatography. Over 50 organic bases are recovered from water at the 1 ppm and 50 ppb levels. Recoveries of over 85% are achieved for most of the compounds studied with at least one of the eluents. The resin procedure shows improved recoveries and reproducibility over a simple ether extraction procedure. Real samples of river water, shale process water, and supernatant from an agricultural chemical disposal pit are analyzed for basic organic material by using the resin procedure. (Author's abstract)
W84-01581

PRECONCENTRATION OF TRACE ELEMENTS IN NATURAL WATER WITH CELLULOSE PIPERAZINEDITHIOCARBOXYLATE AND DETERMINATION BY NEUTRON ACTIVATION ANALYSIS,
Public Health Research Inst. of Kobe City (Japan).
S. Imai, M. Murol, and A. Hamaguchi.
Analytical Chemistry, Vol. 55, No. 8, p 1215-1219, July, 1983. 4 Tab, 4 Ref.

Descriptors: *Trace elements, *Neutron activation analysis, *Water analysis, Natural waters, Preconcentration.

To prepare cellulose piperazinedithiocarboxylate (PID), tosylcellulose was reacted with piperazine to give the aminocellulose which was then reacted with carbon disulfide. The preconcentration of the trace elements was accomplished by the PID column operations. Ten liters of river water or spring water sample was passed through the column at a given pH. The packings were taken out of the column, dried at 110 degrees C, and then burned to ashes in a low-temperature plasma asher. The ashes were encapsulated in polyethylene 'rabbits' of the pneumatic tube system and subjected to neutron irradiation in a reactor. Gamma-ray spectrometry was then performed on the irradiated sample and the concentration of 18 elements in natural water samples was determined. This method may be applied to atomic absorbtion spectrophotometry and emission spectrophotometry since PID can be readily decomposed by low-temperature plasma ashing. This method may be recommended as a simple and rapid simultaneous determination method for trace elements in natural water samples. (Moore-IVI)
W84-01582

PRECISION AND ACCURACY IN THE DETERMINATION OF ORGANICS IN WATER BY FUSED SILICA CAPILLARY COLUMN GAS CHROMATOGRAPHY/MASS SPECTROMETRY AND PACKED COLUMN GAS CHROMATOGRAPHY/MASS SPECTROMETRY,
Environmental Protection Agency, Cincinnati, OH. Office of Research and Development.
J. W. Eichelberger, E. H. Kerns, P. Olynyk, and W. L. Budde.
Analytical Chemistry, Vol. 55, No. 9, p 1471-1479, August, 1983. 5 Fig, 7 Tab, 16 Ref.

Descriptors: *Gas chromatography, *Mass spectrometry, *Organic compounds, Water analysis.

Two general methods for the identification and measurement of organic compounds in water are compared. One method employs packed column chromatography and the other fused silica capillary column chromatography. The two gas chromatography/mass spectrometry (GC/MS) methods use different pH conditions for the liquid-liquid extractions with methylene chloride. Single laboratory total method accuracy and precision data are presented for over 80 analytes in water at the low parts per billion level. With the packed column method, 54% of the analytes have a mean recovery of 70% or more. With the capillary column method, 74% of the analytes have a mean recovery of 70% or greater. Both methods give mean relative standard deviations for concentration measurements of about 20%. (Author's abstract)
W84-01583

DETERMINATION OF HALOGENATED ORGANIC COMPOUNDS IN WATER BY GAS CHROMATOGRAPHY/ATMOSPHERIC PRESSURE HELIUM MICROWAVE-INDUCED PLASMA EMISSION SPECTROMETRY WITH A HEATED DISCHARGE TUBE FOR PYROLYSIS,
Tokyo Univ. (Japan). Dept. of Chemistry.
K. Chiba, and H. Haraguchi.
Analytical Chemistry, Vol. 55, No. 9, p 1504-1508, August, 1983. 5 Fig, 5 Tab, 16 Ref.

Descriptors: *Halogenated hydrocarbons, *Water analysis, *Gas chromatography, Plasma emission spectroscopy, Trihalomethanes, Seawater, Monochlorobenzene, Drinking water, Water pollution.

Gas chromatography/atmospheric pressure helium microwave-induced plasma emission spectrometry has been applied to the determination of halogenated, organic compounds in tap, pond, and river waters and seawater, as well as deionized and distilled waters. A quartz plasma discharge tube of 200 mm length was heated to 900 C for pyrolysis, since a 100 mm long conventional discharge tube without heating showed nonuniform relative responses due to incomplete decomposition of some compounds when it was used to transfer the column effluent to the microwave-induced helium plasma (MIP). Halogenated organic compounds in aqueous samples were collected on an Tenax GC column by a gas purge-and-trap method. Trihalomethane compounds including monochlorobenzene were found at the microgram per liter levels in tap and river waters, while their levels were much lower in pond water and seawater. Deionized and distilled waters also contained halogenated compounds at approximately the same levels as tap water. These results indicate that deionization and distillation processes do not exclude organohalide compounds in tap water. There was no evidence for organoiodine compounds in water. (Moore-IVI)
W84-01584

SCALE MORPHOLOGIC RESPONSE TO AROMATIC HYDROCARBONS,
Grambling State Univ., LA. Dept. of Biology.
V. Henderson.
Bulletin of Environmental Contamination and Toxicology, Vol. 31, No. 3, p 315-321, September, 1983. 4 Fig, 1 Tab, 11 Ref.

Descriptors: *Fish, *Toxicity, *Hydrocarbons, Fish scales, Fuel, Water pollution effects, Melanophores.

A simple and inexpensive procedure was developed to assess the toxic effects of aromatic hydrocarbons utilizing scales, without sacrificing the fish. Mosquito fish (Gambusia affinis) were exposed to 3.45 mg/l hydrocarbons from the water-soluble fraction of shale-derived JP-4 fuel for 48 hr. Scales from the exposed and unexposed fish were examined by light microscopy and scanning electron microscopy (SEM). The changes observed with the electron microscope manifested themselves in an arborization and an increase in total number of melanophores leading to preponderance of stellate-reticulate melanophores. An increase in pigment was a function of the type and number of melanophores present. Surface cell morphology with SEM provides another parameter for assessing damage to cells. This method can drastically reduce the evaluation time required to assess pollutants. (Moore-IVI)
W84-01587

QUALITATIVE AND QUANTITATIVE DETERMINATION OF DISSOLVED HYDROCARBONS IN WATER AND SEDIMENTS (ANALYSE QUALITATIVE ET QUANTITATIVE DE TRACES D'HYDROCARBURES DISSOUS DANS L'EAU ET IMPREGNANT DES SEDIMENTS),
Strasbourg-1 Univ. (France). Lab. de Physicochimie des Hydrocarbures.
P. Rimmelin, P. Muller, M. Sagar, J. Kontaratos, and J. Sommer.
Analusis, Vol. 11, No. 7, p 345-349, August-September, 1983. 4 Fig, 2 Tab, 4 Ref.

Descriptors: *Hydrocarbons, *Water analysis, *Sediment analysis, *Extraction, Gas chromatography, Solvents, Sodium chloride, Methanol.

An inert gas stripping method for the extraction of trace amounts of hydrocarbons from water for gas chromatography is improved by the addition of sodium chloride and methanol. The method can also be applied to contaminated sediments analysis. The method was applied to a mixture of 10 hydrocarbons at 20 C with an output of gas of 120 ml/min under the following conditions; (A) without additive, 60 min analysis time; (B) with 10 g/l NaCl, 30 min; with 2 ml/l methanol, 30 min. The analysis time was cut in half with the additives, and the quantities of extracted hydrocarbons are equal or greater than those extracted in condition A. (Moore-IVI)
W84-01612

CHARACTERISTICS OF ESCHERICHIA COLI GROWN IN BAY WATER AS COMPARED WITH RICH MEDIUM,
Maryland Univ., Cambridge. Center for Environmental and Estuarine Studies.
For primary bibliographic entry see Field 2L.
W84-01649

REDUCTIVE DEHALOGENATIONS OF HALOBENZOATES BY ANAEROBIC LAKE SEDIMENT MICROORGANISMS,
Michigan State Univ., East Lansing. Dept. of Crop and Soil Sciences.
A. Horowitz, J. M. Suflita, and J. M. Tiedje.
Applied and Environmental Microbiology, Vol. 45, No. 5, p 1459-1465, May, 1983. 6 Fig, 1 Tab, 13 Ref.

Descriptors: *Microorganisms, *Dehalogenation, *Halobenzoates, Lake sediments, Halogens, Acclimation, Metabolism, Methane, Chlorobenzoates, Bromobenzoates, Idobenzoates, Anaerobic conditions.

Methane-producing freshwater lake sediment was found to dehalogenate chloro-, bromo-, and iodobenzoates by a reductive reaction in which the halogen was replaced by a hydrogen atom. The identity of the dehalogenated products was confirmed by mass spectrometry, nuclear magnetic resonance, or cochromatography. Removal of the halogens to produce benzoate was necessary before mineralization to CH4 + CO2 could occur. The dehalogenation occurred after a lag period which lasted from 1 week to more than 6 months, depending on the chemical. Dehalogenation was not observed in the absence of CH4 production, and it was inhibited by the addition of 20% O2. Once sediment was acclimated to halobenzoate dehalogenation, new additions of the halobenzoate were degraded without lag. Acclimation was observed regardless of whether the parent substrates were eventually mineralized to CH4 + CO2. Sediment acclimated to bromo- and chlorobenzoate degradation generally metabolized bromo- and chlorobenzoates, but sediment acclimated to iodobenzoate degradation only metabolized iodobenzoate. Prior acclimation of sediment to benzoate decomposition did not alter the pattern of dehalogenation, and sediment acclimated to dehalogenation was not concurrently acclimated to benzoate degradation. The presence of this apparent specificity, the lag period, and subsequent acclimation, together with our findings of the absence of dehalogenation in sterile sediments and by sediments previously incubated at greater than or equal to 30 degrees C, suggests that this reaction was biologically catalyzed. Apparently, a pathway for the reductive dehalogenation of aryl halides is present in anaerobic microorganisms of this methanogenic sediment. (Author's abstract)
W84-01650

THE INTERPRETATION OF COMPLEX CHROMATOGRAMS BY COMPUTER ANALYSIS,
Anglian Water Authority, Huntingdon (England).
C. R. Hayes, and N. P. Weatherill.
Water Resources, Vol. 17, No. 5, p 539-548, May, 1983. 7 Fig, 1 Tab, 2 Ref.

Descriptors: *Gas chromatography, *Mass spectrometry, *Computers, Pollutant identification, Water analysis, Water quality.

A computer system was developed to handle a large volume of data derived from gas chromatographic (GC) and mass spectrometric (MS) analysis of environmental water samples. The system was developed using GC and GC-MS data produced in the analysis of dichloromethane extracts of water samples from five river catchments and three treatment works. GC profiles were quantified to provide a concise presentation of data and MS results, from a limited number of samples, were used to ascribe probable identification to the components of GC profiles for which no MS analysis was performed. The statistical analysis of analytical performance characteristics provided the basis for the method adopted for cross referencing MS and GC data. A method for ranking compound identifications ascribed to GC profile components is based on whether the compound had been previously been identified at the same site and the frequency of occurrence, and whether the compound had previously been identified at the same treatment works or catchment and the frequency of occurrence. (Moore-IVI)
W84-01673

PARTICULATE FORMS OF RADIUM AND BARIUM IN URANIUM MINE WASTE WATERS AND RECEIVING RIVER WATERS,
Ceske Vysoke Uceni Technicke v Praze. Dept. of Nuclear Chemistry.
P. Benes, F. Sebesta, J. Sedlacek, M. Obdrzalek, and R. Sandrik.
Water Resources, Vol. 17, No. 6, p 619-624, June, 1983. 1 Fig, 6 Tab, 9 Ref. IAEA contract 1729/RB.

Descriptors: *Radium, *Barium, *Mine drainage, *Particulates, Uranium mines, Selective dissolution, Coprecipitation, Effluents, Wastewater treatment, Bottom sediments, Suspended solids.

A method of selective dissolution was used for analysis of particulate forms of radium and barium in a system consisting of uranium mine waste waters purified by coprecipitation with barium sulfate and of adjacent river waters. Four particulate forms of both the elements were distinguished: loosely bound, acid soluble, Ba(Ra)SO4 and in crystalline detritus. It was found that the distribution of radium and barium between dissolved and particulate forms in waste waters depended on the time interval elapsing between the sampling and membrane filtration of the waters. No such dependence occurred in river water. The main particulate form of radium and barium in the system was Ba (Ra)SO4. River water upstream of the mine water discharge contained radium mainly in acid soluble form or in crystalline detritus and barium as BaSO4 or crystalline detritus. In unpurified mine effluents, a large part of radium and barium was present as crystalline detritus. Abundance of the loosely bound form was very low in all the samples analyzed. The bond of radium in bottom sediments was approximately the same as that in the solids suspended in waste waters. Suitability and accuracy of the selective dissolution method for analysis of surface and waste waters has been demonstrated by the analysis of the results and by radiotracer experiments. (Author's abstract)
W84-01677

GEOCHEMICAL FACTORS COMPLICATING THE USE OF AUFWUCHS AS A BIOMONITOR FOR LEAD LEVELS IN TWO NEW JERSEY RESERVOIRS,
Rutgers - The State Univ., New Brunswick, NJ. Dept. of Environmental Science.
M. C. Newman, A. W. McIntosh, and V. A. Greenhut.
Water Resources, Vol. 17, No. 6, p 625-630, June, 1983. 4 Fig, 1 Tab, 17 Ref. DE-AC09-76-SR00-H19.

Descriptors: *Lead, *Aufwuchs, *Algae, *Monitoring, Geochemistry, Biomonitoring, Iron, Manganese, Heavy metals, New Jersey.

Material accumulating on glass slides was sampled monthly from two reservoirs for 1 year. Monthly changes in lead concentration in these samples were correlated with fluctuations in associated iron plus manganese concentration. Correlation with changes in algal cell density was also significant (alpha = 0.05), yet not as important in the statistical model as iron plus manganese concentration. Upon microscopic examination, it was evident that the majority of the material removed from the slides was a rust-colored matrix. X-ray analysis revealed that the majority of the lead in the material scraped from the slides was associated with this iron and manganese-rich matrix surrounding the microflora, not with the microflora itself. As a result the material scraped from the slides (often defined as aufwuchs in biomonitoring efforts) could not be considered a valid biomonitor of lead levels in these reservoirs. The local geochemistry, not the biota, was the dominant factor affecting the lead concentrations in the material accumulating on the glass slides. The findings of this study indicate a potential for misinterpretation of biomonitoring efforts employing procedurally defined aufwuchs. (Author's abstract)
W84-01678

IDENTIFICATION OF ORGANIC COMPOUNDS IN LEACHATE FROM A WASTE TIP,
Instituut voor Cultuurtechniek en Waterhuishouding, Wageningen (Netherlands).
For primary bibliographic entry see Field 5B.
W84-01682

FLOW ANALYSIS FOR THE DETERMINATION OF THE MAIN COMPONENTS OF WATERS, RAIN WATER AND DRINKING WATER (DURCHFLUBMETHODEN ZUR BESTIMMUNG VON HAUPTKOMPONENTEN IN GEWASSERN, REGENWASSER UND TRINKWASSER),
Rijksinstituut voor de Volksgezondheid, Bilthoven (Netherlands).
H. F. R. Reijnders, P. H. A. M. Melis, and B. Griepink.
Fresenius Zeitschrift fur Analytische Chemie, Vol. 314, No. 1, p 627-633, April, 1983. 194 Ref.

Descriptors: *Water analysis, *Chemical analysis, Drinking water, Rain, Flow-through analysis, Alkalinity, Chloride, Nitrite, Nitrate, Phosphate, Sulfate, Ammonium, Potassium, Lithium, Sodium, Barium, Calcium, Magnesium, Strontium, Literature review.

A survey of the literature concerning flow-through determination of the main components in various types of water is given. These components are: alkalinity, chloride, nitrite, nitrate, phosphate, sulfate, ammonium, potassium, lithium, sodium, barium, calcium, magnesium and strontium. Details with regard to e.g. type of water, range of the method, interferences etc. are given in a separate compilation which is available from the editor upon request. (Author's abstract)
W84-01729

APPLICATION OF HIGH-SPEED LIQUID CHROMATOGRAPHY USING SOLVENT EXTRACTION OF THE MOLYBDOHETEROPOLY YELLOW TO THE DETERMINATION OF MICROAMOUNTS OF PHOSPHORUS IN WASTE WATERS,
Hamamatsu Univ. (Japan). School of Medicine.
N. Sakurai, K. Kadohata, and N. Ichinose.
Fresenius Zeitschrift fur Analytische Chemie, Vol. 314, No. 1, p 634-637, April, 1983. 4 Fig, 5 Tab, 5 Ref.

Descriptors: *High-speed liquid chromatography, *Phosphorus, *Wastewater analysis, Interference, Silicon compounds, Molybdoheteropoly yellow, Solvent extraction.

In the determination of phosphorus in wastewaters, the usual method is the spectrophotometry of molybdoheteropoly blue, but this is complicated because the color of silico molybdoheteropoly blue, developed simultaneously, can interfere with the determination. A method for determining microamounts of phosphorus in wastewater by HPLC is based on the solvent extraction of molybdoheteropoly yellow with methyl propionate. The corresponding silicon compound is not extracted into this solvent. Thus, the interference by silicon is excluded. Microamounts of phosphorus can be determined not only in waste water but also in river water rapidly and exactly. The limit of detection is 0.5 ppm, and the coefficient of variation is 4.7%. (Moore-IVI)
W84-01730

DETERMINATION OF TRACES OF POLYOXYETHYLENE NON-IONIC SURFACTANTS IN WATER BY SOLVENT EXTRACTION-SPECTROPHOTOMETRY,
Government Industrial Research Inst., Osaka (Japan).
T. Saito, and K. Hagiwara.
Fresenius Zeitschrift fur Analytische Chemie, Vol. 315, No. 1, p 201-214, June, 1983. 2 Fig, 5 Tab, 9 Ref.

Descriptors: *Nonionic surfactants, *Spectrophotometry, Solvent extraction, Sodium picrate, Surfactants, Water analysis, Interference.

The determination of traces of polyoxyethylene non-ionic surfactants (APE) in water is based on the formation of a complex between APE and sodium picrate. The complex is extracted into 1,2-dichloroethane and the absorbance of the solvent phase is measured at 378 nm. Quarternary ammonium surfactants and iron(III) caused positive errors, but the interference due to iron(III) was effectively masked with CyDTA. Humic acids, anionic surfactants, common cations and anions did not interfere. For general type APE (n = 8 - 13) the apparent molar absorptivities of the picrate complexes were 5 - 7 times larger than those of cobalt thiocyanate complexes. Various polyethoxylated compounds in the range of n from 9 to 85 in the same quantity were almost the same in absorbance; recoveries of APE were about 93 - 107%. Therefore this method is quite usable. As little as 0.04 ppm can be determined. In a river water sample 0.04-0.05 ppm and in another case 0.34 ppm of APE were found. (Author's abstract)
W84-01731

DETERMINATION OF PHENOL IN INDUSTRIAL WASTE WATER BY ISOTACHOPHORESIS,
Innsbruck Univ. (Austria). Inst. fuer Radiochemie und Angewandte Physikalische Chemie.
P. A. Pfeifer, G. K. Bonn, and O. Bobleter.
Fresenius Zeitschrift fur Analytische Chemie, Vol. 315, No. 1, p 205-207, June, 1983. 4 Fig, 1 Tab, 14 Ref.

Descriptors: *Phenol, *Isotachophoresis, Industrial wastewater, Wastewater analysis, Electrochemical separation, P-cresol, Vanillin, Interference.

Isotachophoresis constitutes a method of electrochemical separation and identification of ionic substances. By variation of pH, temperature, leading and terminating electrolytes an optimal system for the determination of phenol in waste water was found. All samples were examined without preliminary chemical or physical treatment and therefore a direct analysis of waste water containing phenol is possible. The limit of the sensitivity for phenol is 0.1 ppm. Compounds such as p-cresol and vanillin do not interfere with the phenol determination. (Moore-IVI)
W84-01732

A NEW CALIBRATION METHOD FOR THE NITRATE TRACE DETERMINATION IN WATER SAMPLES (EIN NEUES EICHVERFAHREN ZUR NITRAT-SPURENBESTIMMUNG IN WASSERPROBEN),
Regensburg Univ. (Germany, F.R.). Inst. fuer Anorganische Chemie.
K. G. Heumann, and M. Unger.
Fresenius Zeitschrift fur Analytische Chemie, Vol. 315, No. 5, p 454-458, July, 1983. 2 Fig, 4 Tab, 20 Ref.

Descriptors: *Nitrates, *Mass spectrometry, Isotope dilution analysis, Water analysis, Ionization, Drinking water.

The development of a new method for the mass spectrometric isotope dilution analysis of nitrate traces is described. The formation of negative NO2(-) thermal ions at a hot metal surface is used for the mass spectrometric detection. The optimum conditions for the ionization process depending on the filament material, the filament temperature and the sample compound are discussed. Enriched N15 labeled NO3(-) is used as a spike solution. By this method the nitrate traces could be analyzed down to the ng/g-level. In the concentration range 10-30 micro g/g which is especially important for drinking water, the relative external standard deviation of the analyses is 0.1%. As the described isotope dilution technique is a definitive method without any external standardization it is especially suitable as a calibration method. (Author's abstract)
W84-01733

DETERMINATION OF HEAVY METALS IN SEDIMENTS BY X-RAY FLUORESCENCE IN SEM (QUALITATIVE AND QUANTITATIVE EVALUATION): PART 1:TECHNIQUE (QUALITATIVE UND QUANTITATIVE RONTGENAN-

Group 5A—Identification Of Pollutants

ALYSE VON SCHWERMETALLEN IN SEDIMENTEN IM REM DURCH RONTGEN-FLUORESCENZ-ANREGUNG TEIL 1: METHODIK),
Bonn Univ. (Germany, F.R.). Hygiene Inst.
J. U. Hahn, and H. F. Scholer.
Fresenius Zeitschrift fur Analytische Chemie, Vol. 315, No. 8, p 679-682, August, 1983. 3 Fig, 1 Tab, 17 Ref.

Descriptors: *Heavy metals, *X-ray fluorescence, *Sediment analysis, Scanning electron microscopy, Computers.

A procedure for qualitative and quantitative analysis of sediments is described. The sample preparation and evaluation of the measurement results are suitable for routine analysis. The heavy metals were determined by energy dispersive X-ray fluorescence analysis in SEM (scanning electron microscopy) and the quantitative analysis was carried out by micro-computer. The limits of detection are below 100 ppm. The confidence interval is 99.7%. (Author's abstract)
W84-01735

DETERMINATION OF HEAVY METALS IN SEDIMENTS BY X-RAY FLUORESCENCE IN SEM (QUALITATIVE AND QUANTITATIVE EVALUATION); PART 2: APPLICATION (QUALITATIVE UND QUANTITATIVE RONTGENANALYSE VON SCHWERMETALLEN IN SEDIMENTEN IM REM DURCH RONTGEN-FLUORESCENZ-ANREGUNG; TEIL 2: ANWENDUNG),
Bonn Univ. (Germany, F.R.). Hygiene Inst.
J. U. Hahn, and H. F. Scholer.
Fresenius Zeitschrift fur Analytische Chemie, Vol. 315, No. 8, p 683-686, August, 1983. 1 Fig, 6 Tab, 15 Ref.

Descriptors: *Sediment analysis, *Metals, *X-ray fluorescence, Heavy metals, Cadmium, Chromium, Manganese, Iron, Nickel, Copper, Zinc, Thallium, Arsenic, Lead, Multivariate analysis.

Sediments from a small river (Lauterbach) were examined for the metals and metalloids Cd, Cr, Mn, Fe, Ni, Cu, Zn, Tl, As, Pb. Nineteen samples were taken at regular intervals. The trace metals were determined by means of X-ray fluorescence in scanning electron microscopy. Intercorrelations between various metals were evaluated by multivariate statistical methods. (Author's abstract)
W84-01736

5B. Sources Of Pollution

METHANOGENESIS OF PHENOLIC COMPOUNDS BY A BACTERIAL CONSORTIUM FROM A CONTAMINATED AQUIFER IN ST. LOUIS PARK, MINNESOTA,
Geological Survey, Menlo Park, CA.
E. M. Godsy, D. F. Goerlitz, and G. G. Ehrlich.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 3, p 261-268, March, 1983. 1 Fig, 1 Tab, 9 Ref.

Descriptors: *Groundwater contamination, *Fate of pollutants, Methanogenesis, Phenols, Methane, Coal tar, Industrial wastes.

Groundwater in St. Louis Park, Minnesota has been contaminated by the operation of a coal tar distillation and wood treatment facility. Water samples were collected at three wells from the near-surface groundwater in the contaminated area. Well W13 is located near the centroid of the contaminated zone directly under the area where the plant process liquids penetrated the subsurface. Water from Well P14, located 143 m down gradient in the direction of groundwater flow from Well W13, does not have a hydrocarbon phase but does have a distinct creosote odor. This well penetrates the area of active microbiological activity. Water from Well P119, located 430 m down gradient from Well W13, does not have a distinct creosote odor and is beyond the area of active microbiological activity. The chromatograms of the phenols from samples from Well W13 and those from two laboratory digestors are nearly comparable. The peak heights of the chromatogram of Well P14 are attenuated relative to W13 owing to biodegradation and hydrodynamic dispersion in the groundwater. Phenol, 2-methylphenol, and 3-methylphenol apparently degraded during transport over the 143 m distance from Well W13 to Well P14. This study demonstrated that phenols, a major fraction of coal tar, were degraded in both groundwater and in laboratory digestors with a concomitant production of methane. (Baker-IVI)
W84-01419

CADMIUM UPTAKE AND INDUCTION OF CADMIUM-BINDING PROTEIN IN THE WATERFLEA (MOINA MACROCOPA),
National Inst. for Environmental Studies, Tsukuba (Japan).
M. Yamamura, S. Hatakeyama, and K. T. Suzuki.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 3, p 298-302, March, 1983. 3 Fig, 8 Ref.

Descriptors: *Zooplankton, *Biological magnification, *Cadmium, Moina, Protein, Metallothioneins, Waterflea, Adsorption, Accumulation, Fate of pollutants.

The accumulation and chemical forms of cadmium in the zooplankton, Moina macrocopa, were investigated in order to more fully understand the accumulation of cadmium in various steps through the food chain. M. macrocopa were collected and kept in aerated water tanks at 23 C. Cadmium was added to underground water in the tanks at a concentration of 20 micrograms Cd/liter. The animals exposed to cadmium were collected after 0, 24, 48, and 72 hr. Concentrations of cadmium, zinc, and copper were determined. The concentration of cadmium attained a maximum level after 72 hr. At this time the concentrations of zinc and copper were not affected, remaining at control levels. Approximately 60% of the cadmium in the homogenates was extracted into the supernatant fraction and the metal concentration in the supernatants increased with accumulation of the metal in the animals. The cadmium accumulated in M. macrocopa was mainly bound to the low molecular weight cadmium-binding protein whose molecular weight is smaller than that of mammalian metallothioneins. The protein is a mixture of two isoproteins as in the case of malacostracan metallothioneins. (Baker-IVI)
W84-01421

ACCUMULATION OF SEVEN METALS BY CRASSOSTREA GIGAS, CRASSOSTREA MARGARITACEA, PERNA PERNA, AND CHOROMYTILUS MERIDIONALIS,
Port Elizabeth Univ. (South Africa). Dept. of Zoology.
H. R. Watling.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 3, p 317-322, March, 1983. 3 Tab, 18 Ref.

Descriptors: *Mollusks, *Fate of pollutants, *Accumulation, Chromium, Copper, Zinc, Lead, Cadmium, Nickel, Cobalt, Metals.

The accumulation of seven elements by Crassostrea margaritacea, Perna perna and Choromytilus meridionalis was investigated. The rates of accumulation were compared with those achieved by Crassostrea gigas under the same controlled conditions. Experimental solutions containing 100 micrograms/liter of one of the elements were used. The study showed that all seven elements were accumulated to a greater or lesser extent by each of the four species. Exposures lasted 3 weeks. During this period the oysters accumulated zinc and copper at the fastest rates, lead and cadmium at intermediate rates and the remaining elements were accumulated more slowly. Lead is accumulated at the fastest rate by the mussels. Zinc and cadmium in both mussels and copper in P. perna were accumulated at intermediate rates and, as found in the oyster, nickel, cobalt, and chromium were accumulated very slowly. The zinc levels tested were significantly below those already found in many so-called polluted areas. The toxic effect of copper in possibly causing a lower accumulation rate cannot be discounted. From the point of view of indicating metal pollution in the marine environment, the tissue-metal concentration which is determined for individuals from a polluted environment must be significantly greater than those determined for individuals from an unpolluted area. On the basis of the accumulation factors, it appeared that zinc has not been accumulated under these experimental conditions by either oysters or mussels. Moderate accumulation factors have been determined for cadmium, copper, nickel, and chromium and the very high accumulation factors estimated for lead and cobalt suggest that these elements are accumulated very rapidly. It is suggested that all three species could be used to indicate the presence of each of these elements in the marine environment, with the exception of zinc. (Baker-IVI)
W84-01422

AN ALGAL ASSAY METHOD FOR DETERMINATION OF COPPER COMPLEXATION CAPACITIES OF NATURAL WATERS,
Illinois Inst. of Tech., Chicago. Pritzker Dept. of Environmental Engineering.
H. E. Allen, C. Blatchley, and T. D. Brisbin.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 1, p 448-455, April, 1983. 3 Fig, 2 Tab, 21 Ref. 31-109-38-3660, NOAA-022044030.

*Bioassay, *Algae, Assay, Copper, Complexation, Natural waters, Metal complexes, Toxicity.

For a series of natural waters a comparison was made of the copper complexation capacity as determined by the Davey method using a green algae, Selanastrum capricornutum, to that determined by plotting the free copper ion concentration versus the growth rate. The eight natural water samples included Lake Michigan from Chicago's 31st street pier in September 1978; three bodies of water in Forest Preserve in Cook County, IL in August 1978 and one more in October 1978; and Par and Beaver Ponds and Upper Three Runs River, located in Georgia in April of 1979. The natural water samples were nutrient enriched by the addition of phosphate and nitrate at levels equivalent to those in AAT media (EPA Algal Assay Procedure Bottle Test). The complexation capacities determined for natural waters by the Davey and the biological titration methods were statistically the same. However, these two methods differ in an important way. For Davey's method only those data in the vicinity of the equivalence point are used. For the biological titration all data can be used if the complex is strong. For weaker complexes, the data for total metal concentration similar to that of the complexation capacity will deviate from linear behavior. In these cases the data which deviate can be disregarded. The biological titration method is easier to use because it does not require that a significant number of samples have metal concentrations similar to the value of the complexation capacity. (Baker-IVI)
W84-01427

ORGANOCHLORINE RESIDUES IN ORGANISMS OF TWO DIFFERENT LAGOONS OF NORTHWEST MEXICO,
Universidad Nacional Autonoma de Mexico, Mexico City. Centro de Ciencias del Mar y Limnologia.
M. T. L. Rosales, and R. L. Escalona.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 1, p 456-463, April, 1983. 2 Fig, 3 Tab, 7 Ref.

*Pesticides, *Aquatic life, *Lagoons, Mexico, Fish, Mollusks, DDT, Heptachlor epoxide, Aldrin, Endrin, Dieldrin, Chlorinated hydrocarbons, Tropical regions, Semiarid lands, Mexico.

The concentration of organochlorine compounds was determined in two lagoon systems with different backgrounds: the Yavaros lagoon system in Sonora and the Huizache-Caimanero lagoon complex in Sinaloa Mexico. The Yavaros complex

consists of the Yavaros, Moroncarit, and Etchoropo lagoons, each of which receives drainage water from an extensive agricultural hinterland. The Huizache-Caimanero systems consist of a large two-basined lagoon lying between and having access to the rivers Presidio and Baluarte. The Yavaros area is semi-arid with low summer rainfall. The Huizache-Caimanero is a tropical zone and has a much higher summer rainfall. Levels of organochlorine pesticides (total HCH, total DDT, heptachlor epoxide, aldrin, endrin and dieldrin) were measured in several organisms during one year period, including striped mullet, white mullet, mackerel, flounder, Centropomus pectinatus, C. robalito, shrimp, crab and clams. The Yavaros lagoon has a uniform salinity of approximately 37 0/00 which reflects the high marine influence. In the Moroncarit area the influence of agriculture predominates over the marine effects. The salinity distribution over a year in the Huizache-Caimanero lagoon shows that there is a high evaporation in the area from March to June and an extensive drying of the lagoons which increases salinity. In general, the levels of DDT and dieldrin residues in organisms of the two areas studied are lower than the range of values reported in the literature. The concentration of organochlorine compounds found below the widely accepted standards that represent hazard to human health (500 ng/g wet weight for DDT and 100 ng/g wet weight for dieldrin). (Baker-IVI)
W84-01428

EFFECTS OF GRAYS HARBOR ESTUARY SEDIMENT ON THE OSMOREGULATORY ABILITY OF COHO SMOLTS (ONCORHYNCHUS KISUTCH),
Corps of Engineers, Seattle, WA. Seattle District.
D. M. Kehoe.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 5, p 522-529, May, 1983. 3 Tab, 7 Ref.

*Bottom sediments, *Dredging, *Salmon, *Heavy metals, Estuaries, Grays Harbor, Washington, Salmon, Toxicity, Sodium, Turbidity, Harbors.

In estuaries which have experienced large amounts of heavy metal pollution the bottom sediments tend to bind the heavy metals from the water column and act as a sink for storage of the contaminants. The effect of sediments from Grays Harbor, Washington, on the hypo-osmoregulatory ability of smolting coho salmon was investigated through the measurement of blood sodium levels following seawater challenge. Experiments were designed to simulate, as closely as possible, the effects on migrating juvenile coho salmon of the periodic high suspended sediment levels created by hopper dredges while dredging in the inner harbor. Four experimental groups were established, each consisting of three replicate tanks containing 20 fish per tank. The control group was held in non-contaminated freshwater for 9 days, then immediately subjected to a 24 hr seawater challenge test. The o-hr recovery group was exposed to sediment for 9 days, then immediately subjected to the 24 hr seawater challenge test. The 5-day recovery group was placed in freshwater contaminated with sediment for 9 days, and were then placed into clean freshwater for a 5 day recovery period. They were then subjected to the 24 hr seawater challenge test. The 10-day recovery group was placed in freshwater contaminated with sediment for 9 days and then placed into clear freshwater for a 10-day recovery period. After this they were subjected to the same seawater challenge. A great deal of variation in turbidity levels occurred in the experimental tanks throughout the contaminant exposure period with leveis of about 200 NTU's being reached occasionally. The mean turbidity level in the three control tanks was 0.89 NTU. Chemical analysis of the elutriate from the Grays Harbor samples showed the presence of a variety of heavy metals. Blood sodium levels of groups in the three control tanks had a mean reading of 157 meg/liter; in the three zero-hour recovery tanks a mean of 145 meg/liter; in the three 5-day recovery tanks a mean of 168 meg/liter; and in the 10-day recovery tanks a mean of 181 meg/liter. Dissolved oxygen levels were not below 7.0 milligrams per liter in any tank measured in the study. (Baker-IVI)
W84-01432

DISTRIBUTION OF POLYCYCLIC AROMATIC HYDROCARBONS IN THE SURFICIAL SEDIMENTS OF CASCO BAY, MAINE,
Bigelow Lab. for Ocean Sciences, West Boothbay Harbor, ME.
P. F. Larsen, D. F. Gadbois, A. C. Johnson, and L. F. Doggett.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 5, p 530-535, May, 1983. 1 Fig, 1 Tab, 10 Ref. NA-80-FA-C-0008.

*Hydrocarbons, *Sediments, *Pollutant identification, Fate of pollutants, Casco Bay, Maine, Carcinogens, Polycyclic aromatic hydrocarbons.

Thirty stations were sampled in Casco Bay in April of 1980 to determine the presence of hydrocarbons in the sediments. Each of the 16 PAH's tested was detected at between 1 and 30 of the test sites. Eight compounds: pyrene, benzo-a-anthracene, chrysene, benzo-b-fluoranthrene, benzo-a-pyrene, dibenzo-a,h-anthracene, benzo-g,h,i-perylene and indeno-1,2,3-c,d-pyrene occurred at over 73% of the stations. All 16 individual PAH's exhibited concentrations in the hundred ppb range at specific points and eight exceeded 1,000 ppb wet weight at least at one station. The highest individual concentration was that of benzo-b-fluoranthene at station 37 which measured 4,500 ppb. Individual stations manifested between 3 and 13 PAH compounds with a mean of 8.57. Total concentrations of PAH at the 30 stations ranged between 215 and 14.425 ppb with a mean of 2.164 ppb. With only one exception stations in the upper and mid sections of the Bay were characterized by values of 900 ppb and below. Concentrations above 2,000 ppb were limited to stations in the vicinity of Portland, including the principal shipping channel into Casco Bay and the mouth of the Presumpscot River. It would seem that a definite possibility exists for the contamination of the living marine resources of this commercially important area. (Baker-IVI)
W84-01433

MERCURY DISTRIBUTION IN AN ECOSYSTEM OF THE 'PARQUE NACIONAL DE DONANA,' SPAIN,
Consejo Superior de Investigaciones Cientificas, Madrid (Spain). Inst. de Quimica Organica General.
G. Baluja, L. M. Hernandez, J. Gonzalez, and R. Clavero.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 5, p 544-551, May, 1983. 2 Tab, 12 Ref.

*Mercury, *Birds, *Fish, *Soil, Spain, Fate of pollutants, Ecosystems, Soil contamination, Heavy metals.

The Parque Nacional de Donana in Spain serves as a winter habitat for migratory birds which breed in Northern Europe. Various levels of mercury were found in the soils of the shore around both the Lucio de Mary Lopez and Lucio del Cangrego Grande lagoons located within the ecosystem. The soil around the Mary Lopez lagoon had a mercury load 2.4 times that at the Cangrego Lagoon. The mean level of mercury in the soil of Mary Lopez lagoon amounts to 0.234 ppm and that at the Cangrego amounts to 0.098 ppm. The average mercury content of the crust of the earth has been calculated at about 0.5 ppm. The rushes growing on the shore of the Mary Lopez lagoon contain 0.41 ppm mercury as opposed to 0.17 ppm in rushes growing on the Cangrego shore. Fish sampled in the Cangrego and Mary Lopez lagoons showed various levels of mercury that appear to increase according to feeding habits. A widespread distribution of mercury was noted from data recorded on birds. Birds of exclusively vegetal feeding showed smaller levels of contamination than those with omnivorous food habits. Only the spoon bill, mostly carnivorous, sampled in the Mary Lopez area showed a 0.87 ppm of total mercury, the highest level found. Eggs showed two different mercury levels according to the food habits of the parents. Duck eggs contained a mean level of 0.07 ppm while those from a more carnivorous bird showed a mean of 0.21 ppm, three times higher. Thus it is evident that mercury occurs in this area of the reserve, but it seems that most of this mercury has a natural origin. (Baker-IVI)
W84-01435

ADSORPTION OF FENITROTHION AND 3-METHYL-4-NITROPHENOL ON SOILS AND SEDIMENT,
Lakehead Univ., Thunder Bay (Ontario). Dept. of Chemistry.
W. H. Baarschers, J. Elvish, and S. P. Ryan.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 5, p 621-627, May, 1983. 4 Tab, 16 Ref.

*Fenitrothion, *Absorption, *Soil properties, Phenols, Sediments, 3-Methyl-4-Nitrophenol, Fate of pollutants, Forests, Microbial degradation.

The absorption characteristics of fenitrothion and 3-methyl-4-nitrophenol, its hydrolysis product, on several soils were studied. Four soils and a Lake Superior sediment were used. Both chemicals were adsorbed on sediment and soils in amounts that increased with increasing organic matter content of the adsorbate. Whereas the use of K-values derived from the Freundlich equation has limitations, the use of a modified Freundlich equation presents problems when the slope of the isotherm is appreciably larger than unity. Both compounds can be adsorbed on soils so as to reach concentrations that are fungi-toxic on agar plates. Since compounds adsorbed on soil (and on the organic litter of the forest floor) would not be readily subject to photodegradation, the results of this study indicate that it is necessary to give attention to further studies on the microbial degradation of these compounds. (Baker-IVI)
W84-01439

FRACTIONATION OF PHOSPHORUS AND RELEASABLE FRACTION IN SEDIMENT MUD OF OSAKA BAY,
Osaka Prefecture Fisheries Experimental Station (Japan).
H. Joh.
Bulletin of the Japanese Society of Scientific Fisheries, Vol. 49, No. 3, p 447-454, March, 1983. 7 Fig, 11 Ref.

Descriptors: *Phosphates, *Sediments, Bays, Seawater, Path of pollutants, Anaerobic conditions, Osaka Bay, Japan.

This report discusses fractionation of phosphorus in sediment cores of Osaka Bay and the releasable fraction from sediment to sea water in anaerobic condition. Inorganic phosphate in sediment mud was fractionated into four types: soluble-P, Al-P, Fe-P, and Ca-P by the method of Chang et al. Concentrations of Al-P and Fe-P indicate the highest value in 0-5 cm layer except for Al-P in Stn. 4 which is located at the most inner part of the bay. Ca-P contents show relatively high value for each sediment core, ranging from 110 to 190 micro g per g dry mud, but area and vertical variances were not so clear. As Al-P plus Fe-P contents in the sediment increase exponentially with ignition loss; most phosphates which are associated with pollutant substances in the sediment mud are in these two fractions. Three fractions of phosphate: soluble, aluminum and iron phosphate may be released from the sediment in anaerobic condition. It was proved that contents of phosphate released into sea water increased proportionally to those three fraction contents in sediment mud. (Author's abstract)
W84-01454

WETFALL CHEMISTRY STUDIES AROUND A LARGE COAL-FIRED POWER PLANT IN THE SOUTHEASTERN UNITED STATES,
Brookhaven National Lab., Upton, NY. Atmospheric Sciences Div.
A. A. N. Patrinos, M. T. Dana, and R. E. Saylor.
Journal of Geophysical Research, Vol. 88, No. C13, p 8585-8612, October 20, 1983. 22 Fig, 19 Tab, 57 Ref.

Descriptors: *Acid rain, *Air pollution, *Powerplants, Plume washout, Sulfur, Hydrogen ions, Chloride, Sulfur dioxide, Simulation, Chemistry of precipitation, Gas scavenging.

A wetfall chemistry study was conducted within a 15-km radius of a large coal-fired power plant in the southeastern United States. The study was conducted during the winter of 1981 and included event precipitation sampling on a dense network of 31 stations, selected air chemistry monitoring at two sites, and extensive meteorological measurements. The precipitation samples were analyzed for all major inorganic ionic species, including dissolved sulfur dioxide. The meteorological network included a preexisting network of 49 recording rain gages and four surface windsets, the power plant's fully equipped meteorological station, and a bistatic acoustic sounder. This paper presents the results from five of the sampled storms. Plume washout is evident in most target area samples, and sulfur, hydrogen ion, and chloride ion were found to be the predominant plume-related species. Concentrations in the affected regions exceeded the background levels by up to 100% in the case of sulfur and of hydrogen ion, and by up to 145% in the case of chloride ion. Two of the storms were characterized by excess dissolved SO2 amounts in the target samples; for these storms, scavenging model simulations of dissolved SO2 concentrations indicated that deposition of sulfur by SO2 scavenging within 12 km was probably less than 2% of the total emitted. Based on the measured Cl(-) in rainwater, an estimate of the source strength (coal Cl content) using conventional gas scavenging theory appears reasonable. (Author's abstract)
W84-01492

CHARACTERIZATION OF NONVOLATILE AQUEOUS CHLORINATION PRODUCTS OF HUMIC SUBSTANCES,
Massachusetts Univ., Amherst. Dept. of Chemistry.
J. W. Miller, and P. C. Uden.
Environmental Science Technology, Vol. 17, No. 3, p 150-157, March, 1983. 13 Fig, 1 Tab, 28 Ref.

Descriptors: *Chlorinated hydrocarbons, *Chlorination, *Humic acids, Hydrogen ion concentration, Fulvic acid, Chloroform, Dichloroacetic acid, Trichloroacetic acid, Chloral hydrate.

The formation of nonvolatile chloroorganics produced during the aqueous chlorination of humic substances was followed qualitatively and quantitatively. The effects of reaction time, NaOCl to C ratio, pH, and source of humic material were studied with respect to the quantitative formation of chloroform, dichloroacetic acid, trichloroacetic acid, and chloral hydrate. Other gas-chromatographable chloroorganics formed from the chlorination of fulvic acid were produced at levels below these four compounds. Chlorine-selective fingerprint studies were also undertaken to follow the formation of 17 major chlorinated products. (Author's abstract)
W84-01493

MOBILITY IN SOIL AND PLANT AVAILABILITY OF METALS DERIVED FROM INCINERATED MUNICIPAL REFUSE,
Tennessee Valley Authority, Muscle Shoals, AL. Div. of Agricultural Development.
P. M. Giordano, A. D. Behel, Jr., J. E. Lawrence, Jr., J. M. Solleau, and B. N. Bradford.
Environmental Science Technology, Vol. 17, No. 4, p 193-198, April, 1983. 9 Tab, 16 Ref.

Descriptors: *Fly ash, *Leaching, *Heavy metals, Incineration, Municipal wastes, Cadmium, Lead, Chloride, Soil contamination, Waste disposal.

Fly ash residues from several sites in which solid municipal refuse is being incinerated for energy production were found to contain excessive amounts of cadmium and/or lead according to an empirical extraction test (0.5 N acetic acid) developed by the Environmental Protection Agency. Samples of associated bottom ashes contained acceptable levels of Cd and Pb, but several were marginal with respect to Pb content. Leaching tests clearly demonstrated that Cd and, to a lesser extent, Pb were mobile in soil when applied in a fly ash matrix. The high chloride content (10-12%), which is characteristic of these ashes, resulted in metal complexation and enhanced Cd and Pb mobility in soil. Normally these elements are relatively immobile in soils when applied as inorganic salts or contained in municipal sewage sludge. Plant uptake of Cd and Pb in a greenhouse test was marked when fly or finely ground bottom ashes were solid applied. Phytotoxicity of fly ash appeared to be associated with the high salt content rather than with a specific metal. (Author's abstract)
W84-01495

PARTITION EQUILIBRIA OF NONIONIC ORGANIC COMPOUNDS BETWEEN SOIL ORGANIC MATTER AND WATER,
Oregon State Univ., Corvallis. Environmental Health Sciences Center.
C. T. Chiou, P. E. Porter, and D. W. Schmedding.
Environmental Science and Technology, Vol. 17, No. 4, p 227-231, April, 1983. 2 Fig, 1 Tab, 34 Ref. ES-02400, ES-00210, CR-808046.

Descriptors: *Isotherms, *Soil organic matter, *Partition, Organic compounds, Solutes, Sorption, Aromatic compounds, Polymeric humic substances.

Equilibrium isotherms for the simultaneous uptake of binary nonionic organic compounds from water on soil indicated no competitive effect between the two solutes. This observation supports the hypothesis that partition to the soil organic phase is the primary process for sorption of nonionic organic compounds from water on soil. The partition process between soil organic matter and water was analyzed by using the conventional solution concept for solutes in water and the Flory-Huggins treatment for solutes in the polymeric humic phase. Sorption determined for 12 aromatic compounds on a Woodburn soil shows that the extent of solute insolubility in water (S) is the primary factor affecting the soil organic matter-water partition coefficient (Kom) and that the effect of solute incompatibility with soil organic matter is significant but secondary. This explains the commonly observed correlations of log Kom vs. log S and log Kom vs. log Kow (octanol-water). (Author's abstract)
W84-01497

PARTITIONING OF STRONTIUM-90 AMONG AQUEOUS AND MINERAL SPECIES IN A CONTAMINATED AQUIFER,
National Hydrology Research Inst., Ottawa (Ontario).
R. E. Jackson, and K. J. Inch.
Environmental Science Technology, Vol. 17, No. 4, p 231-237, April, 1983. 6 Fig, 3 Tab, 42 Ref.

Descriptors: *Partition, *Strontium radioisotopes, *Groundwater pollution, Groundwater movement, Adsorption, Sand aquifers, Path of pollutants, Vermiculite, Feldspar.

The geochemical partitioning of a toxic metal contaminant, Sr90, during its migration through a shallow sand aquifer is discussed. Adsorption of Sr90 from the contaminated groundwaters (pH about 6, I about 0.001) causes it to have a migration velocity of only 3% of that of transporting groundwater. Five microscopically identified adsorbents were isolated in the aquifer sediments and showed the following affinity sequence for Sr90: vermiculite > feldspar > biotite > muscovite > quartz. While about 80% of the adsorbed Sr90 is exchangeable with 0.1 M SrCl2, the residual adsorbed Sr90 is strongly correlated with extractable Fe, Al, and Mn, suggesting specific adsorption by these metal oxides. An equilibrium adsorption model was used to determine the partitioning of Sr90 between adsorbents and between solid and solution phases. Over 90% of all Sr90 in the aquifer is adsorbed. Approximately 90% of all adsorbed Sr90 is equally divided between vermiculite and feldspar minerals. (Author's abstract)
W84-01498

STRUCTURE ELUCIDATION OF 3-(2-CHLOROETHOXY)1,2-DICHLOROPROPENE, A NEW PROMUTAGEN FROM AN OLD DRINKING WATER RESIDUE,
Cincinnati Univ., OH. Dept. of Environmental Health.
M. W. Tabor.
Environmental Science Technology, Vol. 17, No. 6, p 324-329, June, 1983. 1 Fig, 3 Tab, 31 Ref. CR806872, CR808603.

Descriptors: *Mutagens, *Chlorinated hydrocarbons, Drinking water, Water pollution, Pollutant identification, Chloroallyl ethers, Promutagens.

A Salmonella TA100 microsomal-dependent mutagen previously isolated from residue organics prepared from drinking water in the 1960s by the carbon-chloroform megasampler procedure has now been tentatively identified as a new choroallyl ether. On the basis of Fourier transform infrared and nuclear magnetic resonance spectroscopies in conjunction with high-resolution mass spectroscopy, a confident structual assignment for this promutagen was elucidated to be 3-(2-chloroethoxy)-1,2-dichloropropene. The compound has not been noted in studies of current drinking water residue organics and the mutagenicity of recent drinking water samples typically does not require such microsomal activation. (Moore-IVI)
W84-01502

APPLICATION OF VAN KREVELEN'S GRAPHICAL-STATISTICAL METHOD FOR THE STUDY OF AQUATIC HUMIC MATERIAL,
Laval Univ., Quebec. Dept. of Soil Sicence.
S. A. Visser.
Environmental Science and Technology, Vol. 17, No. 7, p 412-417, July, 1983. 5 Fig, 5 Tab, 22 Ref.

Descriptors: *Humic acids, *Fulvic acids, Decaying organic matter, Ultraviolet irradiation, Streptomycetes, Soil organic matter, Aquatic environment.

By means of H:C and O:C atomic ratios information was obtained on the basic structure, and on structural changes with varying molecular weight and origin, of fulvic and humic acids sampled at various locations of a watershed within the Laurentide provincial park, Quebec. In order to investigate also the effect of humification, humic matter produced by a streptomycete and sampled at regular intervals during a 6-month incubation period was included in the investigation. Also studied was the effect of ultraviolet irradiation on the structure of either recently formed or more humified humic substances. It was shown that fulvic and humic acids are more alike in aquatic than in terrestrial environments. They are also less aromatic in natural waters than in soils and, at least in the case of fulvic acids, are richer in oxygen. Contrary to what is normally observed for humus from natural environments, it would appear that for certain types of humus such as fulvic acids from a microbial culture, increases in molecular weight or in the degree of humification would result in material with a less aromatic character. Humus obtained from natural waters was found to be in a more advanced state of humification at the end of summer than at the beginning. Recently formed fulvic acids appeared to be very sensitive to ultraviolet irradiation. (Author's abstract)
W84-01508

FECAL COLIFORM LOADINGS FROM BIRDS ON BRIDGES,
Gore and Storrie Ltd., Toronto (Ontario).
M. D. Palmer.
Canadian Journal of Civil Engineering, Vol. 10, No. 2, p 241-247, June, 1983. 4 Fig, 5 Tab, 5 Ref.

Descriptors: *Water pollution sources, *Coliforms, *Birds, *Bridges, Pollution load, Fecal coliforms, Feces, Pigeons, Rideau River.

The fecal coliform loadings to the Rideau River from bird populations resident on bridges were measured for dry weather, summer, low river

flows (8.5-17 cu m/s). The Rideau River has typical velocities to 0.216 km/h. The loadings were estimated by an intensive river sampling program over 4 weeks at river cross sections upstream and downstream of a bridge with birds on the bridge and without birds on the bridge. The birds were temporarily displaced from the bridge with bird nets. Statistical testing of the river cross section geometric means showed the birds to have a significant effect on river fecal coliform levels. From bird census, river water sampling data, and river flow data, a pigeon was estimated to generate on the average a daily loading of between 0.88 and 1.3 x 10 to the 10th power fecal coliform organisms with a standard deviation of approximately 0.39 x 10 to the 10th power. An independent check on the validity of the estimated loadings from resident bird populations at another bridge produced results within 40% of the measured values. (Author's abstract)
W84-01513

SEEPAGE FROM OILFIELD BRINE DISPOSAL PONDS IN UTAH,
Colorado Univ. at Boulder. Dept. of Geological Sciences.
F. G. Baker, and C. M. Brendecke.
Ground Water, Vol. 21, No. 3, p 317-324, May-June, 1983. 4 Fig, 2 Tab, 6 Ref.

Descriptors: *Brine disposal, *Groundwater pollution, Saline water, Seepage, Plumes, Water pollution sources, Water pollution control, Economic aspects, Monitoring, Utah.

Significant amounts of brine produced in conjunction with oil well operations in the Greater Altamont-Bluebell field in Utah have been disposed of to surface impoundments. Mass balance calculations indicate that about 93% of this brine, a total of 4,430 acre-feet (5,450,000 cu m) over the ten-year period studied, is lost through seepage, introducing a total salt load of 200 million pounds (90,000,000 kg) into the shallow aquifer system. Only local problems with groundwater supplies have been observed to date, but estimates of salt-water plume movement indicate that potential adverse economic impacts on irrigators and other water users in the Duchesne River Valley could reach hundreds of thousands of dollars. Lining of disposal ponds and increased use of injection wells will reduce future contamination. A groundwater and surface water monitoring program should be initiated in selected areas to determine the extent of the problem, and to more accurately project the costs and damages caused by salt-water contamination. Initially, resistivity surveys could be made and shallow observation wells be placed around two or three of the largest ponds, in order to detect the salt concentration in the groundwater and to determine the direction of plume movement. (Moore-IVI)
W84-01552

FATE OF ETHION IN CANALS DRAINING A FLORIDA CITRUS GROVE,
Florida Inst. of Tech., Melbourne. Dept. of Environmental Sciences and Engineering.
F. E. Dierberg, and R. J. Pfeuffer.
Journal of Agricultural and Food Chemistry, Vol. 31, No. 4, p 704-709, July/August, 1983. 7 Fig, 1 Tab, 31 Ref.

Descriptors: *Ethion, *Pesticide residues, *Fate of pollutants, Organophosphorus pesticides, Hydrolysis, Irrigation canals, Sediments, Adsorption, Hydrogen ion concentration, Citrus fruits, Florida.

The degradation of ethion, O,O,O',O'-tetraethyl S,S'-methylene bis (phosphorodithioate), in irrigation canal waters draining a citrus grove in South Florida occurs readily by hydrolysis with a half-life of 26 days. The reaction is pH independent from pH 4 to 7 with a pseudo-first-order rate constant of 0.0048/day (half-life of 146 days). Above pH 7 the reaction is pH dependent with a pseudo-first-order rate constant increasing with higher pH values, suggesting a base-catalyzed hyrolysis. The second-order alkaline hydrolysis rate constant is 0.0064/M/day. Half-lives were 62 days at pH 8 and 1 day at pH 10. Adsorption to canal sediments was negligible and desorption was rapid because of absence of significant amounts of organic matter. Calculations based upon solubility and vapor pressures of ethion indicate that the rate of evaporative loss is negligible. Ethion did not accumulate in the sediment and water samples from the irrigation canal following spraying, and levels never exceeded 0.017 mg/L in the water or 0.03 micro g/g (dry weight) in the sediments. This suggests that hydrolysis may be a significant mechanism in the loss of ethion from irrigation canal waters in South Florida.
W84-01556

OCCURRENCE OF BROMIDE IN SOURCE AND TREATED WATERS,
Imperial Coll. of Science and Technology, London (England).
T. V. Luong, C. J. Peters, and R. Perry.
Effluent and Water Treatment Journal, Vol. 23, No. 5, p 192-197, May, 1983. 1 Fig, 4 Tab, 14 Ref.

Descriptors: *Bromide, *Water pollution sources, Groundwater, Surface waters, Natural water, Trihalomethanes, Chlorination, Drinking water, Water treatment.

The method most widely adopted and recommended by the ASTM for determination of bromine is an UV spectrophotometric method based on bromide catalysis of iodine oxidation with a working range of 4-100 micrograms/l of bromide. A comparison is offered of this method against an instrumental neutron activation analysis. For unspiked samples the bromide levels obtained by ASTM were markedly lower than the INAA results. The reason for this divergence is that INAA measures total bromine including bromide, bromate and other forms of inorganic bromine as well as non volatile organic bromine, the ASTM method measures principally bromide and bromate. For tap water samples relatively high organic bromine levels are to be expected as significant amounts are produced during chlorination. Inorganic bromine occurs in natural waters principally as bromide although other forms such as bromate and possibly bromite may also be present. Neither the ASTM nor the INAA methods can distinguish between these species of inorganic bromine. An indirect measure of the organic bromine content can be obtained by the difference between INAA and ASTM determinations. For groundwaters bromide concentrations depend principally on the extent of salt water intrusion and the geochemical formation of the aquifer whereas for surface waters factors such as the extent of reuse, the type and quantity of industrial discharge and the potential of other sources of bromine such as road and agricultural runoff are important. (Baker-IVI)
W84-01569

IDENTIFICATION OF A MEMBRANE FOULANT IN THE ELECTRODIALYTIC RECOVERY OF NICKEL,
Ford Motor Co., Dearborn, MI. Engineering and Research Staff.
H. C. Heller, and V. Markovac.
Analytical Chemistry, Vol. 55, No. 4, p 551A-557A, April, 1983. 5 Fig, 5 Ref.

Descriptors: *Industrial wastes, *Wastewater treatment, *Membrane processes, Water reuse, Nickel, Electroplating, Electrodialysis, Nickel, Membranes.

Some component present in a nickel plating additive formulation of a major supply company severly and rapidly fouled the membranes during an evaluation of the feasibility of nickel recovery by electrodialysis. Electrodialysis experiments were performed in an electrodialysis stackpack containing anion-selective membranes (103.QZL.219) and cation selective membranes (61.CZL.183). In a solution of identical nickel ion concentration obtained from post plating rinse and therefore containing the additive formulation, the voltage required to maintain 12.5 mA/sq cm in the electrodialysis process rose rapidly from 14 to 40 V in less than 60 min, indicating fouling of the electrodialysis membranes. Attempts to remove the fouling species included filtration through 0.25 micron Millipore filters, adsorption on activated carbon, diatomaceous earth, and polymeric adsorbants; and removal with ion-exchange columns. Ion-exchange columns saturated with foulant could be regenerated to 90% or better of their original capacity by treatment with hydrochloric acid or sodium chloride methanol-water solution. Polyallyl sulfonate was identified as a foulant of the membranes in the electrodialysis of the nickel plating solutions. A separate brightener formulation supplied by a different supplier and containing sodium allyl sulfonate exhibited no fouling. (Baker-IVI)
W84-01577

LAKE ST. CLAIR: SINCE THE MERCURY CRISIS,
Michigan Dept. of Natural Resources, Lansing.
J. H. Hartig.
Water Spectrum, Vol. 15, No. 1, p 19-25, Spring, 1983. 8 Fig.

Descriptors: *Fate of pollutants, *Mercury, *Lakes, *Fish, Lake St. Clair, Detroit River, Public Health, Lake Erie, Industrial wastes, Chemical industry, Regulations, Water pollution control.

In 1969 the mercury crisis in Lake St. Clair was clear. The contamination was arising from the Dow Chemical Chlor-Alkali Plant, in Sarnia, Ontario. Mercury had contaminated both the sediments and the fishery of the St. Clair River and lake, and the Detroit River. Today the monitoring programs have shown a significant decrease of mercury in all species of fish. In general, the concentration of mercury in fish from Lake St. Clair is less than one-third what it was in 1970. The decline of mercury in walleye is particularly significant as walleye are the most sought after sport fish in the lake. The Michigan Department of Public Health has dropped walleye, largemouth bass, smallmouth bass, sheepshead, and white bass from the Lake St. Clair's public health advisory. Only muskellunge are advised to be consumed no more than one meal per week because of elevated mercury levels. The decline has resulted mainly from the cessation of discharge of mercury on the St. Clair River and to the translocation of mercury-containing sediments from Lake St. Clair to Lake Erie. After May of 1970 mercury discharges to the St. Clair River were negligible. Resuspension and onward transportation of mercury containing sediments from Lake St. Clair to Lake Erie has resulted in a 64% decrease in sediment mercury in Lake St. Clair from 1970 to 1974. No major effects were noted in Lake Erie as a result of continued loading of mercury containing sediment from Lake St. Clair, via the Detroit River. The dilution factor in Lake Erie may have been adequate to prevent large-scale uptake of mercury by fishes, or mercury contaminated sediments are being bound and covered up by new sediments. (Baker-IVI)
W84-01640

MICROBIAL TRANSFORMATION OF NITROAROMATIC COMPOUNDS IN SEWAGE EFFLUENT,
Cornell Univ. Agricultural Experiment Station, Ithaca, NY. Dept. of Agronomy.
L. E. Hallas, and M. Alexander.
Applied and Environmental Microbiology, Vol. 45, No. 4, p 1234-1241, April, 1983. 7 Fig, 2 Tab, 26 Ref. PHS Training Grant ES-07052.

Descriptors: *Nitroaromatic compounds, *Wastewater, *Effluent, *Microbial degradation, Aromatic compounds, Aerobic conditions, Anaerobic conditions, Metabolism, Benzenes, Fate of pollutants.

The transformation of mono- and dinitroaromatic compounds was measured in sewage effluent maintained under aerobic or anaerobic conditions. Most of the nitrobenzene, 3- and 4-nitrobenzoic acids, and 3- and 4-nitrotoluenes and much of the 1,2- and 1,3-dinitrobenzenes disappeared both in the presence and absence of oxygen. Under anaerobiosis, 2,6-dinitrotoluene and 3,5-dinitrobenzoic acid disappeared slowly, but no loss was evident in 28 days in aerated sewage. Aromatic amines did not

accumulate during the aerobic decomposition of the mononitro compounds. They did appear in nonsterile, but not in sterile, sewage incubated aerobically with the dinitro compounds and anaerobically with all the chemicals. Analysis by gas chromatography and combined gas chromatography-mass spectrometry showed that aniline was formed from nitrobenzene, toluidine was formed from 3- and 4-nitrotoluenes, and aminobenzoic acid was formed from 3- and 4-nitrobenzoic acids under anaerobiosis, and that nitroaniline was formed from 1,2- and 1,3-dinitrobenzenes, aminonitrotoluene resulted from 2,6-dinitrotoluene, and aminonitrobenzoic acid was a product of 3,5-dinitrobenzoic acid under both conditions. The isomeric forms of the metabolites were not established. Aniline, 4-toluidine, and 4-aminobenzoic acid added to sewage disappeared from aerated nonsterile, but not from sterile, sewage or sewage in the absence of oxygen. 2-Nitroaniline, 2-amino-3-nitrotoluene, and 2-amino-5-nitrobenzoic acid added to sewage persisted for at least 60 days in aerobic or anaerobic conditions. Gas chromatographic and gas chromatographic-mass spectrometric analyses demonstrated that acetanilide and 2-methylquinoline were formed from aniline, 4-methylformanilide and 4-methylacetanilide were formed from 4-toluidine, 2-methylbenzimidazole was a product of 2-nitroaniline, and unidentified benzimidazoles were formed from 2-amino-3-nitrotoluene in the absence of oxygen, and that 2-nitroacetanilide and 2-methyl-6-nitroacetanilide were formed from 2-nitroaniline and 2-amino-3-nitrotoluene, respectively, in the presence or absence of oxygen. It is suggested that the transformations of widely used nitroaromatic compounds should be further studied because of the persistence and possible toxicity of products of their metabolism. (Author's abstract)
W84-01647

ENTRAINMENT OF VIRUSES FROM SEPTIC TANK LEACH FIELDS THROUGH A SHALLOW, SANDY SOIL AQUIFER,
Brookhaven National Lab., Upton, NY. Dept. of Energy and Environment.
J. M. Vaughn, E. F. Landry, and M. Z. Thomas.
Applied and Environmental Microbiology, Vol. 45, No. 5, p 1474-1480, May, 1983. 1 Fig, 4 Tab, 25 Ref.

Descriptors: *Wastewater disposal, *Enteroviruses, *Entrainment, Viruses, Aquifers, Water pollution sources, Groundwater pollution, Water quality, Coliforms, Long Island, New York.

Movement of naturally occurring human enteroviruses from a subsurface wastewater disposal system through a shallow aquifer was studied on the south shore of eastern Long Island, New York. The potential for significant entrainment of virus particles was evidenced by their recovery at down-gradient distances of 67.05 m and from aquifer depths of 18 m. The specific limits of virus entrainment through the system could not be determined, as wells had not been installed beyond 67 m down-gradient of deeper than 18 m. A significant negative correlation was observed between virus occurrence and the distance from the 'septage' (leaching pool) source. Virus occurrence could not be statistically correlated with either total or fecal coliforms, indicating the limitations of current microbial water quality indicators for predicting virological quality of groundwater. (Moore-IVI)
W84-01651

LONGEVITY OF SALMONELLA TYPHIMURIUM IN TILAPIA AUREA AND WATER FROM POOLS FERTILIZED WITH SWINE WASTE,
Auburn Univ., AL. Dept. of Fisheries and Allied Aquacultures.
D. A. Baker, R. O. Smitherman, and T. A. McCaskey.
Applied and Environmental Microbiology, Vol. 45, No. 5, p 1548-1554, May, 1983. 3 Fig, 3 Tab, 53 Ref.

Descriptors: *Salmonella, *Wastewater aquaculture, *Aquaculture, *Tilapia, Public health, Wastewater disposal, Animal wastes, Bacteria.

Salmonella contamination is a potential public health concern in wastewater aquaculture, because humans and farm animals may shed salmonellae intermittently in their feces. Thus, fish being cultured in wastewater might come in contact with salmonellae. Field studies were conducted during the spring and summer of 1980 using 14 8,000 liter pools stocked with Tilapia aurea. Salmonella typhimurium declined rapidly when inoculated into T. aurea culture pools fertilized with fresh swine waste. Within the water column, a 95% decline of viable cells occurred during the first 6 h. Isolation of viable salmonellae was possible at 16 days post-inoculation, but not at 32 days. Similarly, salmonellae could be detected in the viscera and epithelium of T. aurea at 16 days, although not at 32 days. Salmonellae were not isolated from the fish flesh, nor was there evidence of septicemic infection. (Moore-IVI)
W84-01655

SEASONAL VARIATION IN SURVIVAL OF ESCHERICHIA COLI EXPOSED IN SITU IN MEMBRANE DIFFUSION CHAMBERS CONTAINING FILTERED AND NONFILTERED ESTUARINE WATER,
Virginia Inst. of Marine Science, Gloucester Point. Dept. of Estuarine and Coastal Ecology.
I. C. Anderson, M. W. Rhodes, and H. I. Kator.
Applied and Environmental Microbiology, Vol. 45, No. 6, p 1877-1883, June, 1983. 4 Fig, 43 Ref.

Descriptors: *Escherichia coli, *Estuarine environment, *Water temperature, Bacteria, Microorganisms, Public health, Water quality.

Human fecal Escherichia coli isolates were exposed over a seasonal cycle to estuarine water in diffusion chambers filled with double-filtered (0.45 and 0.2 micro m) and nonfiltered water. Laboratory manipulations of E. coli cultures before estuarine exposure were reduced to minimize sublethal stress, and nonselective or resuscitative enumeration techniques were employed to maximize recovery of stressed cells. E. coli was capable of extended survival during in situ exposure to estuarine water, provided eucaryotes were excluded from diffusion chambers. Survival was directly related to temperature in absence of the eucaryote component of the natural microbiota. Although it was not possible to prevent eventual bacterial contamination in double-filtered water, there was no direct evidence that such contamination affected E. coli survival. Conversely, E. coli disapparance was most pronounced at warmer temperatures in the presence of the natural microbiota, and decline coincided with increasing eucaryote densities. In contrast, the decline of E. coli during winter was similar in both filtered and nonfiltered seawater. (Author's abstract)
W84-01660

ENVIRONMENTAL EFFECTS OF IN SITU COAL GASIFICATION,
Wyoming Univ., Laramie. Dept. of Civil Engineering.
M. J. Humenick, T. F. Edgar, and R. J. Charbeneau.
AICHE Symposium Series, Vol. 79, No. 226, p 139-153, 1983. 2 Fig, 6 Tab, 54 Ref.

Descriptors: *Coal gasification, *Water pollution sources, Organic compounds, Phenols, Gasification, Fate of pollutants, Surface waters, Groundwater pollution, Environmental effects.

This review evaluates the environmental impact of underground coal gasification. Documentation projects that pollutants are released to groundwaters when normal flow returns to a postgasification zone. During the gasification phase, the high temperature gases produced can migrate into surrounding strata, where cooling occurs with attendant condensation or deposition of various chemical compounds. The bulk of the condensed materials are organic compounds including light hydrocarbons, phenols, oils, and tars. After gasification is completed, an ash residue remains in the burn cavity which yields soluble inorganic compounds to reinvading groundwaters. Wastewaters generated above the ground arise principally from the gas cooling step, which causes condensation of water, oils, and tars from the gas generated in situ. The condensate may contain three phases - water, oil and solids. The water phase can contain high concentrations of phenols and other organic compounds, ammonia, hydrogen sulfide, carbon dioxide and various inorganic compounds. (Baker-IVI)
W84-01662

WATER QUALITY MONITORING AT THE HOE CREEK TEST SITE: REVIEW AND PRELIMINARY CONCLUSIONS,
Lawrence Livermore National Lab., CA.
F. T. Wang, S. W. Mead, and D. H. Stuermer.
AICHE Symposium Series, Vol. 79, No. 226, p 154-173, 1983. 21 Fig, 7 Tab, 8 Ref. DOE Contract W-7405-Eng-48.

Descriptors: *Underground coal gasification, *Coal aquifers, *Water pollution sources, Groundwater pollution, Sorption, Organic compounds, Sand aquifers, Water quality, Hoe Creek, Wyoming.

Underground coal gasification (UCG) may introduce a broad range of residual gasification products into the groundwater of a coal aquifer. Such contaminants may be of environmental significance if they find their way, in sufficient concentrations, into surface waters or aquifers from which water is extracted for drinking or agriculture. Sorption of many contaminants by the coal itself is an important factor in restricting the migration of these contaminants in the groundwater. Field studies at Hoe Creek in northeastern Wyoming have shown that sorption of organic compounds by coal is not as effective as expected, perhaps because the coal surface area is limited. Futhermore, if severe roof collapse has taken place during gasification, non-coal aquifers located above the gasified coal seam may be interconnected with the coal aquifer. Contaminants may enter these non-coal aquifers, in which sorption is even less effective. The Hoe Creek II and III experiments are a study the contamination of a sand aquifer located above a gasified coal seam in a hydrological recharge area. Preliminary results indicate that the water in the overlying sand aquifer is much less contaminated with organic compounds than that in the gasified coal aquifer. (Moore-IVI)
W84-01663

EUTROPHICATION PROBLEMS IN EMILIA ROMAGNA, ITALY,
Watson Hawksley, High Wycombe (England).
M. V. Haddrill, R. Keffer, G. C. Olivetti, G. B. Polleri, and F. Giovanardi.
Water Resources, Vol. 17, No. 5, p 483-495, May, 1983. 6 Fig, 8 Tab, 17 Ref.

Descriptors: *Nutrients, *Pollution load, *Phosphorus removal, *Nitrogen removal, *Eutrophication, Wastewater treatment, Detergents, Animal wastes, Land disposal, Sludge digestion, *Italy, Emilia Romagna, River Savio, Adriatic Sea.

Between 1977 and 1979 a study identified the sources and forms of the nutrients phosphorus and nitrogen discharged from the basin of the river Savio, in Emilia Romagna, Italy. Septic tanks remove 30% of the phosphorus load from sewage in the study area, and there was a statistically significant reduction in the load in the sewage as a result of the introduction of low phosphorus detergents. The flow and nutrient loads carried by the river were monitored during dry and wet weather to establish annual nutrient loads carried to the Adriatic Sea. While it was possible to reasonably balance the measured phosphorus loads with estimated loads, there was considerable disagreement between the measured and estimated nitrogen loads for the year July 1978 - June 1979, with the estimated load much lower than the measured load. An extensive sampling program was carried out to quantify the principal sources of nutrients of which the most important were pig farming, man and chemical fertilizers. A significant reduction in nutrient load could be achieved by treatment of wastewaters from pig farming. Treatment could include energy recovery by digestion of sludges or

disposal of wastewaters to land in a controlled manner, thereby reducing considerably to load reaching the sea. (Moore-IVI)
W84-01670

PARTICLE-SIZE DISTRIBUTION AND PHOSPHORUS LEVELS IN SOIL, SEDIMENT, AND URBAN DUST AND DIRT SAMPLES FROM THE MENOMONEE RIVER WATERSHED, WISCONSIN, U.S.A.,
Wisconsin Univ.-Madison. Dept. of Soil Science.
A. Dong, G. V. Simsiman, and G. Chesters.
Water Resources, Vol. 17, No. 5, p 569-577, May, 1983. 1 Fig, 3 Tab, 11 Ref. EPA grant R005142.

Descriptors: *Phosphorus, *Particle size, *Water pollution sources, Sediments, Soil type, Urban areas, Suspended sediments, Roads, Nonpoint pollution sources, Wastewater treatment plant, Wisconsin, Menomonee River Watershed.

Soil, bottom sediment, suspended sediment, and urban street dust and dirt samples from the Menomonee River Watershed, Wisconsin, were dispersed by ultrasound, fractionated and analyzed for the P content of each of three particle-size fractions. The major soil types in the watershed were used as a reference for comparing particle-size distribution and P content in urban street dust and dirt, and in sediments. Phosphorus level was found to be greater in the clay-sized particles than in the sand- or silt-sized particles of urban street dust and dirt samples, but 48% of the P was in the sand-sized fraction because of the predominance of sand-sized particles in these samples. The highest P level in the clay-sized fraction of the bottom sediments occurred at the site below a sanitary treatment plant (STP) outfall with secondary treatment capability. The P level found below a tertiary STP outfall was equal to the level found in agricultural areas. When using P level in sediment for locating areas of possible P input to the river, the clay-sized fraction of bottom sediments was more precise than P levels in unfractionated samples. (Author's abstract)
W84-01674

SPECIATION (INCLUDING ADSORBED SPECIES) OF COPPER, LEAD, NICKEL AND ZINC IN THE MEUSE RIVER; OBSERVED RESULTS COMPARED TO VALUES CALCULATED WITH A CHEMICAL EQUILIBRIUM COMPUTER PROGRAM,
Liege Univ. (Belgium). Dept. of Botany.
C. Mouvet, and A. C. M. Bourg.
Water Resources, Vol. 17, No. 6, p 641-649, June, 1983. 6 Fig, 3 Tab, 34 Ref.

Descriptors: *Bottom sediments, *Heavy metals, *Speciation, *Adsorption, Copper, Lead, Nickel, Zinc, Chemical equilibrium, Trace metals, Computers, Organic matter, Suspended sediments, Meuse River, Eysden, Netherlands.

Bottom sediment samples (13) were collected from a single site on the Meuse River at Eysden, Netherlands during 1978 and 1979. The adsorption of trace metals on sediments was interpreted in terms of competition between metals and protons for surface sites. Surface constants were determined for Cu, Zn and Cd (10 to the -1.8, 10 to the -3.6 and 10 to the -3.7). The constants for Pb, Ni, Ca and Mg (10 to the -1.7, 10 to the -3.8, 10 to the -6.5 and 10 to the -5.2) were estimated using a correlation between hydrolysis and surface constants. A chemical equilibrium computer program in which surface sites (for adsorption reactions) are treated as conventional ligands was used to calculate the speciation of Cu, Pb, Ni and Zn in the Meuse River. When the sample contents of humic acids are high and the suspended matter concentration is low, the calculated percentages of metal adsorbed is underestimated. A slight change in the assumed adsorption capacity of those suspended particles yields excellent results. Dissolved trace metal concentrations in the Meuse River are controlled by adsorption and not by precipitation mechanisms. The relationship between organic matter and suspended matter greatly influences the adsorption of metals like Cu and Pb. (Moore-IVI)
W84-01680

IDENTIFICATION OF ORGANIC COMPOUNDS IN LEACHATE FROM A WASTE TIP,
Instituut voor Cultuurtechniek en Waterhuishouding, Wageningen (Netherlands).
J. Harmsen.
Water Resources, Vol. 17, No. 6, p 699-705, June, 1983. 5 Fig, 3 Tab, 9 Ref.

Descriptors: *Leachates, *Organic compounds, *Waste dumps, Heavy metals, Amines, Alcohols, Hydrocarbons, Esters, Terpenes, Phthalates, Fermentation, Pollutant identification.

The first type of leachate was collected from a municipal waste dump (tip) in the acidification stage. The organic load of this leachate was high and consisted mainly of free volatile acids, over 95% of the total organic carbon (TOC). Volatile amines and ethanol were also present (0.8 and 0.7% of the TOC respectively). The leachate was extracted with hexane and the extract was analyzed with infrared and nuclear magnetic resonance spectroscopy and a gas chromatograph-mass spectrometer combination. In the extract alcohols, hydrocarbons, esters, terpenes and phthalates were identified. High molecular weight compounds were present only in a low concentration. The second type of leachate was collected from a waste dump in the methane fermentation stage. The organic load was relatively low. An important part of the organics was identified as high molecular weight compounds. About 32% of the organic carbon consisted of compounds with a molecular weight over 1000. Acids, amines and alcohols were not detected. The organic compounds present were end products of degradation processes. There was a remarkable difference in heavy metal content between the two types of leachate. During the acidification stage, metals are more soluble because of the lower pH and by complexation with the free volatile acids. In the methane fermentation stage, the acids dissappear, the pH rises and there is only a relatively small amount of organic compounds left, which results in a drastic fall in the metal concentrations, except for lead. (Moore-IVI)
W84-01682

MIGRATION OF CONTAMINANTS IN GROUNDWATER AT A LANDFILL: A CASE STUDY; 1. GROUNDWATER FLOW AND PLUME DELINEATION,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
D. S. MacFarlane, J. A. Cherry, R. W. Gillham, and E. A. Sudicky.
Journal of Hydrology, Vol. 63, No. 1-2, p 1-29, May, 1983. 9 Fig, 1 Tab, 31 Ref.

Descriptors: *Pollutant migration, *Groundwater pollution, *Landfills, *Leachates, Chloride, Sulfate, Conductance, Water temperature, Water table mounding, Permeability coefficient, Groundwater movement, Plumes, Groundwater recharge, Mixing, Dispersion.

A landfill-derived contaminant plume with a maximum width of 600 m, a length of 700 m and a maximum depth of 20 m in an unconfined sand aquifer was delineated by means of a monitoring network that includes standpipe piezometers, multilevel point-samplers and bundle-piezometers. The extent of detectable contamination caused by the landfill, which began operation in 1940 and which became inactive in 1976, was determined from the distributions of chloride, sulfate and electrical conductance in the sand aquifer, all of which have levels in the leachate that are greatly above those in uncontaminated groundwater. The maximum temperature of groundwater in the zone of contamination beneath the landfill is 12 C, which is 4-5 C above background. The thermal plume in the aquifer extends 150 m downgradient from the center of the landfill. A slight transient water table mound exists beneath the landfill in the late spring and summer in response to snowmelt and heavy rainfall. Beneath the landfill, the zone of leachate contamination extends to the bottom of the aquifer, apparently because of transient downward components to hydraulic gradient caused by the water-table mound and possibly because of the higher density and lower viscosity of the contaminated water. Values of hydraulic conductivity, which show variations due to local heterogeneity, were obtained from slug tests of piezometers, from pumping tests and from laboratory tests. Because of the inherent uncertainty in the aquifer parameter values, the 38-yr. frontal position of the plume calculated using the Darcy equation with the assumption of plug flow can differ from the observed frontal position by many hundreds of meters, although the use of mean parameter values produces a close agreement. The width of the plume is large relative to the width of the landfill and can be accounted for primarily by variable periods of lateral east- and westward flow caused by changes in water-table configuration due to the variable nature of recharge. Northward from the landfill, the vertical thickness of the plume decreases and the top of the plume is farther below the water table. The thickness of the zone of uncontaminated water downflow from the landfill increases. Because dispersion in the vertical direction is weak, there is very little mixing between the overlying zone of recharge water and the contaminant plume. Concentration profiles are irregular beneath and near the landfill and become smooth downgradient where the maximum concentrations are much less than those beneath the landfill. These features are attributed to a strong influence of longitudinal dispersion. The plume passes beneath a small shallow stream near the landfill without significant influence on the stream. (Author's abstract)
W84-01684

MIGRATION OF CONTAMINANTS IN GROUNDWATER AT A LANDFILL: A CASE STUDY; 2. GROUNDWATER MONITORING DEVICES,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
J. A. Cherry, R. W. Gillham, E. G. Anderson, and P. E. Johnson.
Journal of Hydrology, Vol. 63, No. 1-2, p 31-49, May, 1983. 5 Fig, 13 Ref.

Descriptors: *Groundwater pollution, *Monitoring, *Sampling, Plumes, Piezometers, Landfills, Leachates, Water quality, Water table, Sand aquifers, Networks.

Six types of devices for groundwater monitoring were used on an experimental basis in the investigation of the plume of contamination in the unconfined sandy aquifer at the Borden landfill. These include: standpipe piezometers, water-table standpipes, an augerhead sampler, suction-type and positive-displacement-type multilevel point-samplers, and bundle-piezometers. With the exception of the first two, each of these devices provides a means of obtaining vertical sample profiles of groundwater from a single borehole. The auger-head sampler, which is a device that is attached to the cutting head of conventional continuous-flight hollow-stem augers, yields samples from relatively undistributed aquifer zones as the augers are advanced downward in the borehole from one depth of sampling to another. This method is a rapid means of acquiring water-quality profiles for mapping the distribution of a contaminant plume. The other three profiling devices can be used to establish permanent networks for groundwater-quality monitoring. A suction-type multilevel sampler consists of twenty or more narrow polyethylene or polypropylene tubes contained in a PVC casing that is capped at the bottom. Each tube extends to a different depth and is attached to a small screened sampling point that extends through the casing to draw water from the aquifer when suction is applied. A positive-displacement multilevel sampler is similar except that each sampling point is connected to a positive-displacement pumping device located inside the PVC casing adjacent to the screen. Use of the suction-type multilevel sampler is limited to zones where the water table is less than the suction-lift depth of 8 or 9 m. The positive-displacement sampler can be used even if the water table is at a much greater depth. A bundle-piezometer consists of 1.2-cm O.D. flexible polyethylene tubes, each with a short screened section at the bottom, fastened as a bundle around a semi-rigid center-piezometer constructed of thick-walled 2-cm O.D. PVC pipe. In shallow water-table areas water is withdrawn from each of the tubes and from the PVC piezometer by suction. In areas with a deep water table, samples are obtained

by bailing with a narrow tube with a check valve on the bottom or by displacement using a double- or triple-tube gas-drive sampler. The positive-displacement multilevel sampler or use of the gas-drive samplers in the bundle-piezometers provide the best opportunities for collecting samples that can be filtered and have preservatives added without the water being influenced excessively. Networks of these three types of devices for multilevel groundwater monitoring were installed in the Borden aquifer of means of hollow-stem augers. The devices are particularly well suited for use in aquifers composed of cohesionless sand or gravel that have little or no clay and groundwater flow that is primarily horizontal. When 8-cm diameter hollow-stem augers are used, as many as eight polyethylene tubes are included conveniently in each bundle-piezometer. If augers with a large hollow-stem are used, more tubes can be assembled in each bundle. (Author's abstract)
W84-01685

MIGRATION OF CONTAMINANTS IN GROUNDWATER AT A LANDFILL: A CASE STUDY; 3. TRITIUM AS AN INDICATOR OF DISPERSION AND RECHARGE,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
B. C. E. Egboka, J. A. Cherry, R. N. Farvolden, and E. O. Frind.
Journal of Hydrology, Vol. 63, No. 1-2, p 51-80, May, 1983. 10 Fig, 34 Ref.

Descriptors: *Groundwater movement, *Tritium, *Tracers, Groundwater pollution, Plumes, Landfills, Leachate, Radioactive tracers, Chloride, Sulfate, Hydrodynamic dispersion, Precipitation, Mixing, Simulation.

Tritium serves as an identifier or tracer of post-1952 water in groundwater flow systems, because major atmospheric testing of nuclear weapons began in 1953. The distribution of 3H in and near the contaminant plume at the Borden landfill was determined by analysis of samples from multilevel point-samplers and from bundle-piezometers. The contaminant plume, which was delineated using Cl(-) and SO4(2-) patterns, was found to contain a large zone of tritiated water and a small zone with no detectable H3. Landfilling operations at the site began in 1940, and as the plume developed in the period from 1940 to 1952, any natural H3 that may have existed in the plume during this period is now below the detection level. During the years in the 1960's in which peak H3 concentrations occurred, values of thousands of tritium units (TU) in precipitation were common and levels of many hundreds of TU or higher existed almost continuously. In the zone of tritiated water in the plume and in the tritiated zone in the natural groundwater up- and downgradient of the plume, all of the sample points except three in the plume had concentrations below 150 TU. Two of these three have concentrations below 290 TU. The general occurrence in the aquifer of H3 levels that are much below the high levels that existed in precipitation prior to the 1970's is attributed to radioactive decay and to the effect of longitudinal hydrodynamic dispersion that has caused mixing of the tritiated groundwater with older untritiated water. Simulated H3 distributions using longitudinal dispersivity values in the range of 30-60 m gave H3 distributions similar to the field values. The strong longitudinal dispersion is believed to be caused by mixing between the ubiquitous layers of fine- and medium-grained sand and silty sand that comprise the aquifer. An estimate of the average annual rate of recharge that has contributed to the groundwater zone beneath the landfill during the bomb-tritium period was obtained by comparing the input of H3 to an area segment of the landfill with the H3 contained within a groundwater flow tube leading from the specified area along the centerline of the contaminant plume. This approach yielded a minimum average annual recharge rate of approximately 50%, with the main cause of uncertainty being the extent of the area in which recharge occurs. (Moore-IVI)
W84-01686

MIGRATION OF CONTAMINANTS IN GROUNDWATER AT A LANDFILL: A CASE STUDY; 4. A NATURAL-GRADIENT DISPERSION TEST,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
E. A. Sudicky, J. A. Cherry, and E. O. Frind.
Journal of Hydrology, Vol. 63, No. 1-2, p 81-108, May, 1983. 15 Fig, 3 Tab, 26 Ref.

Descriptors: *Groundwater movement, *Tracers, *Dispersion, Landfill, Leachates, Chlorides, Path of pollutants, Groundwater pollution, Simulation, Hydraulic gradient.

A natural-gradient tracer test using a chloride solution with an initial injection volume of 0.7 cu m was performed in the sandy aquifer at the Borden site. The solution was injected into five well points set about 1 m below the water table in an uncontaminated zone situated above the contaminant plume at a location 450 m downflow from the landfill. Soon after injection, the tracer slug gradually split into two halves, one half moving horizontally at an average velocity of 0.0000029 m/s and the other horizontally at 0.00000082 m/s. Although the split has been attributed to local lateral heterogeneity, the nature of the heterogeneity and its influence on the hydraulic-head distribution were not clearly distinguishable in the field data obtained before, during and after the test. The chloride patterns for each of the two halves of the tracer slug evolved into Gaussian forms although the patterns demonstrated some irregularity at early time. The relatively smooth Gaussian forms were unexpected because the aquifer has numerous small-scale heterogeneities observed in vertical cores obtained from the tracer zone and because the glaciofluvial origin of the aquifer suggests that heterogeneities are not laterally continuous. Simulated chloride distributions from a three-dimensional analytical solution to the advection-dispersion equation were fitted to the field data to obtain best-fit estimates of the values of longitudinal, transverse-horizontal and transverse-vertical dispersivity at various travel distances for each of the two halves of the tracer zone. This is the first known field test that has permitted the estimation of three principal dispersion coefficients in layered media. The longitudinal dispersivity was found to increase from 0.01 m at a distance of 0.75 m from the source to 0.08 m at 11.0 m. The transverse-horizontal dispersivity increased also to a value of 0.03 m at 11.0 m. Transverse-vertical dispersion was very weak and was accounted for by molecular diffusion. The relative lack of vertical dispersion is consistent with the shape of the plume of leachate contamination from the landfill. The observed increase in dispersivity along the path of migration is likely caused by heterogeneities. (Moore-IVI)
W84-01687

MIGRATION OF CONTAMINANTS IN GROUNDWATER AT A LANDFILL: A CASE STUDY; 5. CATION MIGRATION IN THE DISPERSION TEST,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
J. T. Dance, and E. J. Reardon.
Journal of Hydrology, Vol. 63, No. 1-2, p 109-130, May, 1983. 12 Fig, 3 Tab, 16 Ref.

Descriptors: *Groundwater movement, *Tracers, *Path of pollutants, Calcium, Magnesium, Sodium, Potassium, Groundwater pollution, Landfill, Leachate, Model studies, Dispersion.

A shallow natural-gradient tracer test was conducted in an unconfined sandy aquifer at the Borden landfill site in June 1978. The tracer injected was a chloride solution containing approximately equimolar concentrations of the major cations at levels significantly above those in the background groundwater. Samples collected during monitoring of the tracer were analyzed for calcium, magnesium, sodium and potassium. The results showed an order of attenuation for major cations of K > Mg > Na. Ca, which was the dominant species on the exchange sites before injection of the tracer solution, was liberated during flow of the solution, resulting in the development of a calcium halo at the leading edge of the tracer solution. A one-dimensional mixing-cell model was used to simulate the results of the injection experiment. Both the field and model results show that the chemical composition of the background groundwater is changed due to exchange reactions as it flows in the path of the injection solution. These influences continue until all the exchange sites along the flow path re-equilibrate to their former pre-injection values by the passage of background groundwater. The migration of Na(+) in the flow system is observed to closely parallel the movement of Cl(-) although the maximum concentrations are decreased over the concentration at injection. Mg(2+) migrates downflow at a rate slower than Cl(-), and at a much reduced concentration reflecting a strong tendency for sorption onto exchange sites. Both model and field results show pronounced K(+) attenuation during flow of the injection solution. The bulk of the injected potassium was sorbed very close to the injection wells and is slowly liberated by interaction of background groundwater following the passage of the injection solution. (Moore-IVI)
W84-01688

MIGRATION OF CONTAMINANTS IN GROUNDWATER AT A LANDFILL: A CASE STUDY; 6. HYDROGEOCHEMISTRY,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
R. V. Nicholson, J. A. Cherry, and E. J. Reardon.
Journal of Hydrology, Vol. 63, No. 1-2, p 131-176, May, 1983. 18 Fig, 5 Tab, 66 Ref.

Descriptors: *Groundwater pollution, *Groundwater movement, Landfills, Leachates, Plumes, Calcium, Sulfates, Iron, Bicarbonates, Water quality, Calcite, Heavy metals, Organic carbon, Posassium, Magnesium, Sodium, Path of pollutants.

Multilevel point-samplers located on a longitudinal cross-section through the plume of contaminated groundwater in the sand aquifer at the abandoned Borden landfill were used to obtain a suite of small-volume samples for analysis of major ions and of minor and trace-level inorganic constituents. Calcium is the dominant cation and sulfate and biocarbonate are the dominant anions in the contaminant plume, with maximum concentrations of 400, 2000 and 1200 mg/l, respectively. Beneath the landfill the most highly contaminated water in the aquifer has total dissolved solids of 4000 mg/l. Sulfate and iron are the only inorganic constituents that exceed the recommended limits for drinking water. The plume contains above-background concentrations of dissolved zinc and manganese. No heavy metals or other hazardous inorganic trace elements occur at levels above the maximum limits for drinking water. The plume contains levels of total dissolved organic carbon that are above background levels, ranging from 30 mg/l beneath the landfill to 5 mg/l near the front of the plume. Calcite dissolution is the origin of much of the dissolved inorganic carbon and some of the calcium in the plume. Most of the sulfate and much of the calcium in the plume appears to be derived from gypsum in construction debris in the landfill. Some of the dissolved iron in the plume results from the release under reducing conditions of iron from ferric iron coatings on sand grains located in the aquifer beneath the landfill and in the layers in the refuse. Dissolved sulfide is present at only very low concentrations and is probably controlled by ferrous sulfide solubility. Exchange of cations between the aquifer material and the leachate-contaminated groundwater is an apparent cause of calcium release and subsequent precipitation of calcite in the plume. As much of 80% of the K(+), 20% of the Mg(2+) and 15% of the Na(+) in the plume exists on the exchange sites. (Moore-IVI)
W84-01689

MIGRATION OF CONTAMINANTS IN GROUNDWATER AT A LANDFILL: A CASE STUDY; 7. DC, VLF, AND INDUCTIVE RESISTIVITY SURVEYS,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
J. P. Greenhouse, and R. D. Harris.
Journal of Hydrology, Vol. 63, No. 1-2, p 177-197, May, 1983. 9 Fig, 19 Ref.

Descriptors: *Groundwater pollution, *Landfills, *Path of pollutants, *Resistivity, Groundwater movement, Geophysics, Model studies, Leachate, Geohydrology.

Direct-current (DC), very-low-frequency (VLF) and inductive resistivity surveys of the abandoned landfill at Canadian Forces Base Borden were undertaken initially to assist in mapping the migration of contaminants and continued to assess the relative usefulness of the three techniques for the task. All three techniques were successful in outlining the regions of highest landfill-derived dissolved constituents in the sand aquifer, but the electromagnetic methods have a significant advantage over DC resistivity in both resolution and cost. This conclusion is very site-specific; it is important to evaluate geophysical methods through preliminary modelling before undertaking field work at a new site. Where the contaminant levels at Borden are less than about twice background, mapping their distribution with surface geophysics became unreliable. Surface surveys are ultimately limited in their usefulness by natural scatter in the apparent resistivity, variations which are unrelated to the variations in contaminant level. This lithological and topographical 'noise' can easily mask the detail of a contaminant pattern and is generally inseparable from contaminant-related variations. If geophysical monitoring is to be useful, it is essential that resistivity surveys be undertaken as part of the pre-landfill hydrogeological studies in order to separate the natural scatter from post-landfill surveys. (Moore-IVI)
W84-01690

EXPERIMENTAL INVESTIGATIONS OF UNCONFINED AQUIFER POLLUTION FROM RECHARGE BASINS,
Atomic Energy of Canada Ltd., Pinawa (Manitoba).
V. Guvanasen, and R. E. Volker.
Water Resources Research, Vol. 19 No. 3, p 707-717, June, 1983. 21 Fig, 1 Tab, 19 Ref.

Descriptors: *Groundwater pollution, *Aquifers, Groundwater recharge, Model studies, Mathematical models, Computer models, Recharge rate, Mixing, Velocity.

Experiments in a sand-filled flume simulate contaminant movement in an unconfined aquifer from a long strip recharge basin. Sodium chloride is used as a tracer with its distribution being monitored via electrical conductivity measurements controlled and stored through a minicomputer. The effects of initial saturated depth and magnitude of the recharge rate on the pattern of contaminant movement can be considered in two phases. The first phase involves vertical mixing under the basin, while the second involves horizontal movement and mixing away from the recharge zone. The initial aquifer depth has a significant influence on the thickness of the mixing zone as well as on the inclination of the contaminant front to the horizontal direction. Comparisons with results from numerical models are provided for the speed of movement of the contaminant front and the thickness of the mixing zone as well as for the rise in the free surface level. (Moore-IVI)
W84-01713

KINETIC ANALYSIS OF STRONTIUM AND POTASSIUM SORPTION ONTO SANDS AND GRAVELS IN A NATURAL CHANNEL,
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2K.
W84-01715

SIMULATION OF SOLUTE TRANSPORT IN A MOUNTAIN POOL-AND-RIFFLE STREAM WITH A KINETIC MASS TRANSFER MODEL FOR SORPTION,
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2K.
W84-01716

IDENTIFYING SOURCES OF GROUNDWATER POLLUTION: AN OPTIMIZATION APPROACH,
Geological Survey, Menlo Park, CA.
S. M. Gorelick, B. Evans, and I. Remson.
Water Resources Research, Vol. 19, No. 3, p 779-790, June, 1983. 6 Fig, 9 Tab, 28 Ref. NSF grant CME-8008943.

Descriptors: *Groundwater pollution, *Water pollution sources, *Solute transport, Simulation, Linear programming, Least squares regression, Error analysis, Model studies, Solute transport, Leakage.

Least squares regression and linear programming for least absolute error estimation are each combined with groundwater solute transport simulation to identify the locations and magnitudes of aquifer pollutant sources. Pollutant sources are identified by matching simulated and measured nonreacting solute concentration data. Known hydraulic parameters are assumed, but concentration data errors are considered explicitly. The identification models are demonstrated and compared using two hypothetical aquifer systems, one for the steady state case and the other for the transient case. Steady state models identified unknown pipe leak locations and the leak magnitudes based upon sparse and spatially distributed chloride and tritium data. The number of likely leak locations was restricted in the models by employing mixed integer programming and stepwise multiple regression. Transient models identified several annual disposal fluxes in the aquifer based upon concentration histories collected at observation wells. Conservative solute concentration data were abundant and contained substantial errors. Minimizing either least absolute or least squared errors was successful in identifying pollutant sources. Error analysis is demonstrated for the results given by either method. (Moore-IVI)
W84-01721

EFFICIENT FINITE ELEMENT TECHNIQUE FOR MODELING TRANSPORT IN FRACTURED POROUS MEDIA; 1. SINGLE SPECIES TRANSPORT,
GeoTrans, Inc., Reston, VA.
For primary bibliographic entry see Field 2F.
W84-01726

ON THE BEHAVIOR OF ENVIRONMENTAL POLLUTANTS IN ARTIFICIAL AQUIFERS (ZUM VERHALTEN VON UMWELTCHEMIKALIEN IN KUNSTLICHEN GRUNDWASSERGERINNEN),
V. Betz, G. Fischer, H. Gorbauch, H. H. Rump, and B. Scholz.
Fresenius Zeitschrift fur Analytische Chemie, Vol. 315, No. 5, p 464-474, July, 1983. 10 Fig, 6 Tab, 14 Ref.

Descriptors: *Groundwater pollution, *Path of pollutants, Landfills, Leachates, Water pollution sources, Simazine, Lindane, Trichloroethane, Tetrachloroethane, Aquifers.

Selected chemical substances (simazine, lindane, tri-, tetrachloroethene) were fed into an artificial aquifer (100 m) operated with diluted seepage water from an aerobic landfill. Numerous sampling points made it possible to obtain more information about a three-dimensional distribution of the substances within the aquifer. Elimination and retention can be observed as well. Problems of sampling and analytical procedures are discussed. It was obvious that the methods of sampling and determination required certain adaptions because of the difficult local conditions and the complex matrix composition, respectively. The work was carried out within the scope of an interdisciplinary research program. (Author's abstract)
W84-01734

SLAKING MODES OF GEOLOGIC MATERIALS AND THEIR IMPACT ON EMBANKMENT STABILIZATION,
E. F. Perry, and D. E. Andrews.
Transportation Research Record, Vol. 873, p 22-28, 1982. 3 Fig, 2 Tab, 5 Ref.

Descriptors: *Mine wastes, *Spoil banks, *Slaking, Infiltration, Sheet erosion, Water pollution sources, Appalachian Basin.

The results of a study of the impacts of slaking on surface mine spoils in the Appalachian Basin are discussed. Representative samples were collected for laboratory analyses from core borings near the active highwall and from test pits excavated in fresh and 2-, 5-, and 10-year-old spoils from four selected mine sites. Extensive qualitative and semi-quantitative data were collected on the behavior, causes, and effect of slaking materials. Three slaking models were identified in the field: (a) slaking to constituent grain size; (b) chip slaking to thin, platy fragments; and (c) slab or block slaking to large, approximately equidimensional fragments. These modes are dependent on inherent material properties such as bedding, cementation, and grain size and may affect overall spoil pile or embankment stability. Slaking to inherent grain size promoted surface crusting, reducing infiltration and accelerating sheet erosion. Stability problems in embankments and spoil piles can be anticipated by observing the rate, degree, and modes of slaking. (Author's abstract)
W84-01759

DYNAMIC ADVECTIVE WATER QUALITY MODEL FOR RIVERS,
Ohio State Univ., Columbus. Dept. of Civil Engineering.
K. W. Bedford, R. M. Sykes, and C. Libicki.
Journal of Environmental Engineering, Vol. 109, No. 3, p 535-554, June, 1983. 5 Fig, 2 Tab, 34 Ref.

Descriptors: *Water quality, *Storm runoff, *Mathematical models, Hydrodynamics, Plankton, Sedimentation, Diffusion, Light effects, Turbulence, Biochemical oxygen demand, Nitrogen, Orthophosphate, Olentangy River, Ohio.

A dynamic water quality model for storm induced flows in rivers is presented. The hydrodynamic portion is solved by a four-point implicit Newton-Raphson procedure, while the water quality code is formulated with a Holley-Preissmann nonlinear formulation. The water quality model represents the effects of biodegradation by plankton, sedimentation, and diffusion of material into the benthos by a single turbulence dependent decay term. Eight constituents are employed and the effects of light shading are considered. Two simple tests were used to provide simple initial calibrations. The first test, the propagation of a Gaussian wave, demonstrated the necessity of higher order treatment of the water quality numerical analog. The second test was a steady state test of the water quality model against data from the Olentangy River. The minimum kinetic structure required for Ohio streams should include CBOD, organic nitrogen, ammonia nitrigen, nitrate nitrogen, and orthophosphate. (Author's abstract)
W84-01767

ACID RAIN MODEL: CANOPY MODULE,
Tetra Tech, Inc., Lafayette, CA.
C. W. Chen, R. J. M. Hudson, S. A. Gherini, J. D. Dean, and R. A. Goldstein.
Journal of Environmental Engineering, Vol. 109, No. 3, p 585-603, June, 1983. 4 Fig, 7 Tab, 31 Ref.

Descriptors: *Acid rain, *Canopy, *Water pollution sources, Throughfall, Dry deposition, Forest watersheds, Nitrification, Oxidation, Acidity, Particulates, Air quality, Woods Lake, New York.

As a part of the Integrated Lake-watershed Acidification Study, and acid rain model is being developed to provide quantitative linkage between acid deposition and lake acidification. A canopy model has been developed to calculate throughfall characteristics based on canopy properties, ambient air quality, and precipitation quantity and quality. The processes considered include wet and dry deposition, leaf exudation, nitrification, and oxidation of SO2 and NOx. The canopy model requires only standard input data that can be obtained by use of rain gages, thermometers, dry and wet collectors. The model has been calibrated with data collected at Woods Lake in the Adirondack Mountains of New York. The model has accurately simulated throughfall volume and the concentration of 15 throughfall chemical constituents. Ammonium, NH4(+) accumulated on the canopy is nitrified rapidly, resulting in an increase in acidity and nitrate fluxes. The dominant process occurring in

the coniferous canopy is dry deposition. Calculations suggest that dry deposition measured by bulk collectors grossly underestimates the total amount of dry deposition to the forested watershed. The enrichment of acidity in coniferous throughfall is derived primarily from the accumulation of acidic air particulates. The dominant process occurring in the deciduous canopy is exudation. This partially neutralizes the acidic deposition. (Moore-IVI)
W84-01769

5C. Effects Of Pollution

EFFECTS OF CRUDE OIL AND NAPHTHALENE ON GROWTH, CALORIC CONTENT, AND FAT CONTENT OF PINK SALMON JUVENILES IN SEAWATER,
National Marine Fisheries Service, Auke Bay, AK. Auke Bay Lab.
A. Moles, and S. D. Rice.
Transactions of the American Fisheries Society, Vol. 112, No. 2A, p 205-211, March, 1983. 1 Fig, 4 Tab, 22 Ref.

Descriptors: *Salmon, *Toxicity, *Oil, *Hydrocarbons, Growth, Juvenile growth stages, Naphthalene, Water pollution effects.

Juvenile pink salmon Oncorhynchus gorbuscha were exposed for 40 days to stable, sublethal concentrations of naphthalene (<0.80 mg/liter) and the water-soluble fraction of Cook Inlet crude oil (<0.87 mg/liter total aromatic hydrocarbons). All fish were fed equal daily rations of Oregon Moist Pellet Formula II. Concentrations (percentage of the 96-hour LC50, median lethal concentration) of 10% naphthalene and 14% water-soluble fraction of crude oil did not affect wet weight or length of exposed fish. At higher concentrations, however, growth per day determined from wet weight decreased with increased toxicant concentrations. Change in length of the fish was not a sensitive measure of toxicity. Fish exposed for 40 days to concentrations of toxicants as low as 33% of the 96-hour LC50 weighed significantly less than control fish ($P<0.05$). Juveniles exposed to the water-soluble fraction of crude oil had slower growth rates than those exposed to the same concentration (percentage of the LC50) of naphthalene. Fish exposed to either naphthalene or the the water-soluble fraction of crude oil had decreased caloric content; however, fat content of the fish was not affected. Chronic marine oil pollution at a concentration as low as 0.40 mg/liter total aromatic hydrocarbons could reduce growth of juvenile pink salmon. (Author's abstract)
W84-01403

SIMULATION OF STRIPED BASS EGG AND LARVA DEVELOPMENT BASED ON TEMPERATURE,
National Marine Fisheries Service, Woods Hole, MA. Northeast Fisheries Center.
J. Boreman.
Transactions of the American Fisheries Society, Vol. 112, No. 2B, p 286-292, March, 1983. 4 Fig, 1 Tab, 23 Ref.

Descriptors: *Water temperature, *Bass, Fish eggs, Larvae, Mortality, Simulation, Growth, Mathematical models, Hudson River.

Comparisons of simulated and observed egg and larva abundance patterns for Hudson River striped bass Morone saxatilis during 1975 and 1976 provided support for a previously stated hypothesis that a sudden drop in water temperature during late May 1976 was associated with almost complete disappearance of cohorts spawned before that date. The major period of mortality for the earlier-spawned cohorts may have occurred during or immediately following egg hatching rather than immediately following yolk absorption as had been previously postulated. (Author's abstract)
W84-01407

COMPARATIVE TEMPERATURE-DEPENDENT GROWTH RATES OF LARGEMOUTH AND SMALLMOUTH BASS FRY,
Oak Ridge National Lab., TN. Environmental Sciences Div.
C. C. Coutant, and D. L. DeAngelis.
Transactions of the American Fisheries Society, Vol. 112, No. 3, p 416-423, May, 1983. 2 Fig, 1 Tab, 20 Ref. W-7405-eng-26.

Descriptors: *Bass, *Growth, *Water temperature, Juvenile growth stages, Predation.

First-month growth was temperature-dependent for fry of largemouth bass Micropterus salmoides and smallmouth bass M. dolomieui that were raised simultaneously under identical conditions. Similar temperatures (25-27 C) produced the fastest growth rates in both species, although largemouth bass grew most rapidly at the higher end of this range. Largemouth bass generally grew faster than smallmouth bass, particularly in the 25 to 30 C range (average 1.4 times). Variance about the mean standard length increased at higher temperatures. Differing temperature-dependent growth rates and size distributions for the two species may influence their relative abilities to survive predation and to form strong year classes in temperature regimes that differ due to latitude or weather. (Author's abstract)
W84-01416

RELATIONSHIP BETWEEN OPTIMUM TEMPERATURES FOR GROWTH AND PREFERRED TEMPERATURES FOR THE YOUNG OF FOUR FISH SPECIES,
Ecological Analysts, Inc., Sparks, MD.
R. L. Kellogg, and J. J. Gift.
Transactions of the American Fisheries Society, Vol. 112, No. 3, p 424-430, May, 1983. 1 Fig, 3 Tab, 10 Ref.

Descriptors: *Fish behavior, *Water temperature, *Growth, Bass, Perch, Catfish, Shiner, Thermoregulation.

Optimum temperatures for growth and temperature preference were estimated and compared for young striped bass Morone saxatilis, white perch Morone americana, white catfish Ictalurus catus, and spottail shiner Notropis hudsonius to determine how closely behavioral thermoregulation corresponded to optimal growth temperatures. Differences between the final preferenda and the optimum growth temperatures were less than 2 C. The percentage of preferred temperatures that were within the temperature range corresponding to 75-100% of maximum growth was 76-100%. Only a small percentage (0.17%) of preferred temperatures were greater than the upper limit of the range supporting 75% or more of maximum growth, indicating that fish were avoiding temperatures that were suboptimal for prolonged exposures. (Author's abstract)
W84-01417

TOXICITY OF TEXAN PETROLEUM WELL BRINE TO THE SHEEPSHEAD MINNOW (CYPRINODON VARIEGATUS), A COMMON ESTUARINE FISH,
Fish and Wildlife Service, Victoria, TX.
J. K. Andreasen, and R. W. Spears.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 3, p 277-283, March, 1983. 1 Fig, 1 Tab, 16 Ref.

Descriptors: *Environmental effects, *Brines, Water pollution effects, Saline water, Industrial wastes, Oil industry, Fish, Toxicity, Minnows, Estuaries.

A series of tests was conducted including tolerance testing with artificial sea salts and with petroleum brine in two different dilution waters. The 96 hr LC50 for sheepshead minnows exposed to artificial seasalt was 60 0/00. The 96 hr LC50 for petroleum brine diluted with deionized water was 35 0/00. This salinity occurred when the test water consisted of about 55% brine. For brine diluted with seawater the LC50 was 52 0/00 or 60% dilution. Analysis of test water showed that concentrations of calcium and manganese were much higher and the concentrations of sulfate was lower in petroleum brine diluted with either deionized water or seawater than in normal seawater. While sheepshead minnows are hardy in their tolerance of salinity, petroleum brine differs from normal seawater in the relative concentration of various ions. The results of these tests showed that laboratory petroleum brines are acutely toxic to sheepshead minnows when diluted about 40% with seawater to a salinity of 52 0/00. Petroleum brine mixed 50% with seawater to a salinity of 37 0/00 was acutely toxic to white and brown shrimp. The toxicity of petroleum brine in a natural situation is determined by the amount of brine being discharged, the efficiency of the brine/oil separator, the volume of the receiving water, and the rate at which mixing and exchange take place. Reductions in the freshwater inflow to Texas estuaries or increases in brine discharge will increase the probability of toxic conditions being created in some estuarine systems. (Baker-IVI)
W84-01420

A SIMPLE TOXICITY APPARATUS FOR CONTINUOUS FLOW WITH SMALL VOLUMES: DEMONSTRATION WITH MYSIDS AND NAPHTHALENE,
Lehigh Univ., Bethlehem, PA. Dept. of Biology.
For primary bibliographic entry see Field 7B.
W84-01424

HEAVY METAL CONCENTRATIONS IN TISSUES OF VIRGINIA RIVER OTTERS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.
K. L. Anderson-Bledsoe, and P. F. Scanlon.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 1, p 442- 447, April, 1983. 1 Tab, 14 Ref.

*Water pollution effects, *Otters, *Heavy metals, Metals, Roanoke, Virginia, Accumulation, Lead, Cadmium.

Tissue concentrations of heavy metals in otters trapped in Virginia were studied. Median concentrations of lead and cadmium found in the otter tissues were considered to be well below toxic concentrations and mean lead concentrations were similar to those found in Canada geese and mallards without evidence of ingested lead shot. The concentration of lead in bone is indicative of chronic exposure to lead since bone is the primary long term storage site for lead. The highest concentrations of lead found in river otters were in bone samples from 1980-1981 though median concentrations were relatively low. Mean concentrations of lead and cadmium were similar to mean concentrations found in whole body samples of small mammals trapped near roadways of low traffic densities but were higher than those in small animals trapped in control areas. River otters can possibly be adversely affected by the combined effects of those concentrations of cadmium and lead present in fish species and in sediments which otters probably ingest with food. Median concentrations of lead and cadmium in sediment samples taken at three stations located relative to a heavily travelled highway of Back Creek near Roanoke, Virginia ranged from 4.9 to 8.1 microgram/g dry weight and 0.02 to 0.04 microgram/g dry weight. (Baker-IVI)
W84-01426

BEHAVIORAL RESPONSE OF MALLARDS TO CONTAMINATED DRINKING WATER,
Michigan State Univ., East Lansing. Dept. of Fisheries and Wildlife.
B. L. Rowe, and H. H. Prince.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 5, p 505-510, May, 1983. 1 Fig, 1 Tab, 14 Ref.

*Behavior, *Water birds, *Drinking water, Water pollution effects, Birds, Ducks, Water pollution effects, Avoidance response, Hydroquinone, Copper sulfate, Simazine, Organic compounds.

Male gamefarm mallards were housed in individual compartments with temperatures varying from 18 to 26 C. Water consumption was measured for 12

birds given a choice between distilled water and distilled water containing one of three concentrations of hydroquinone, copper sulfate or simazine based on percent active ingredient. Each chemical was offered for a 15 day treatment period which followed a 10 day acclimation period. Treatment solutions consisted of 100, 500 or 1000 ppm hydroquinone, 30, 60, and 100 ppm copper sulfate, or 5, 20 and 50 ppm simazine. Mallards drank an average of 353 g of water per day during the treatment period. When offered copper sulfate treated water at 100 ppm, the mallards shifted their consumption to prefer the treated water supply. Hydroquinone treated water was avoided. Ducks given copper sulfate treated water were undergoing prebasic molt which may have influenced their response as energy needs increase during molt and trace mineral requirements may arise. Results of the study simply imply that waterbirds may be able to avoid polluted water systems even at low non-toxic levels of contamination. (Baker-IVI)
W84-01430

ACCLIMATION OF CHANNEL CATFISH (ICTALURUS PUNCTATUS) TO NITRATE,
C. S. Tucker, and T. E. Schwedler.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 5, p 516-521, May, 1983. 3 Tab.

*Fish, *Nitrates, *Acclimatization, Methemoglobin, Catfish, Channel catfish, Water quality, Water pollution effects, Lakes, Ponds, Fish behavior, Fish farming, Fish stocking, Chlorides.

The possibility that channel catfish can acclimate to nitrate was studied. In tests with fish that had not previously been exposed to more than 0.01 mg/l, the fish developed higher levels of methemoglobin than fish with an immediate past history of exposure to relatively high NO2(-)/Cl(-) ratios. In channel catfish fingerlings (45 g average weight) not previously exposed, the percent methemoglobin decreased during the study period as the NO2(-):Cl(-) molar ratio decreased. Within one day after being stocked into a pond containing about 2000 fingerlings that had been exposed to higher concentrations than 3.0 mg/l NO2(-)-N for at least the preceding two weeks and where the total alkalinity was 277 mg/liter as CaCO3, methemoglobin values had increased to 56%. For at least four days the unacclimated fish has percent methemoglobin values more than twice as high as acclimated fish, with levels not decreasing to comparable levels until 15 days after stocking. In another experiment, the mean methemoglobin in fish receiving a single dose of 3.28 mg/l NO2(-)-N was 72%, much higher than the predicted value of 39% methemoglobin. The findings could have implications for both research and commercial culture pond management. In west central Mississippi nitrate induced methemoglobinemia is currently managed by adding a chloride salt to decrease the NO2(-):Cl(-) molar ratio to 0.25. This results in methemoglobin levels between 25 and 30%, and is sufficient to prevent death of fish in the pond. However, if the pond is stocked with fish previously unexposed to high NO2(-)/Cl(-) molar ratios the stocked fish may develop methemoglobin levels much higher than the indigenous population and the resulting severe methemoglobinemia in the stocked fish may result in death or stress, particularly if dissolved oxygen levels are marginally low. (Baker-IVI)
W84-01431

HISTOPATHOLOGIC EFFECTS OF JP-4 AVIATION FUEL ON FATHEAD MINNOWS (PIMEPHALES PROMELAS),
Air Force Aerospace Medical Research Lab., Wright-Patterson AFB, OH.
J. R. Latendresse II, and J. W. Fisher.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 5, p 536-543, May, 1983. 3 Fig, 2 Tab, 10 Ref.

*Fish, *Toxicity, *Fuel, Hydrocarbons, Oil industry, Water pollution effects, Minnows.

Fathead minnows were used to determine which tissues and organs were affected by acute exposure to the water soluble fraction (WSF) of JP-4, an aviation fuel derived from petroleum. The only lesions strongly implicated as being caused by exposure to WSF JP-4 were degeneration and necrosis of segments of the mucosa covering the olfactory rosette. A low incidence of cellular alterations was found in the pseudobranch and gill of exposed fish suggesting possible toxicant related effect. Degeneration and necrosis of the nasal mucosa were absent in the control and 10 dose groups, but were present in 50% of the group exposed to 10 mg/l WSF JP-4 and these lesions were seen in high-dose subjects as early as six hours after exposure. Affected segments of the mucosa often appeared only slightly thickened. Focal cellular alterations were noted in acidophilic cells of the pseudobranch in about 1/4 of the fish exposed to 5 and 10 mg/l WSF JP-4. These alterations included acute cellular swelling, cytoplasmic vacuolization, and cytoplasmic inclusions. Other microscopic observations of low incidence in control and exposed fish that were not considered to be related included the following: choroiditis of the eye, granulomatous thyjitis, and hepatocellular cytoplasmic vacuolar changes. (Baker-IVI)
W84-01434

EFFECT OF CALCIUM AND ALUMINUM CONCENTRATIONS ON THE SURVIVAL OF BROWN TROUT (SALMO TRUTTA) AT LOW PH,
Central Electricity Generating Board, Ratcliffe-on-Soar (England). Freshwater Biology Unit.
D. J. A. Brown.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 5, p 582-587, May, 1983.

*Calcium, *Aluminum, *Trout, *Survival, Acidity, Fish, Water pollution effects, Toxicity.

Survival times of yolk sac fry of brown trout were determined at various levels of pH and at different concentrations of calcium and aluminum solutions. In the absence of aluminum, mortalities occurred at pH 4.5 only with 0.25 and 0.5 mg/l of calcium. In solutions containing 0.25 mg/l of aluminum, however, a complete range of responses was noted, from no or very low survival with 0.5 mg/l calcium to almost complete survival with 2.0 mg/l of calcium. Solutions containing 0.5 mg/l of aluminum lead to almost complete mortalities with calcium concentrations of 0.25 and 0.5 mg/l and still significant mortalities at higher calcium concentrations. There is a tendence for higher pHs to be more toxic especially in solutions containing 0.5 mg/l of aluminum. Overall one of the most striking results was the difference between the numbers surviving in solutions containing 0.5 mg/l of calcium and less when compared with those in 1.0 mg/l of calcium or more. It would appear that although the relationship between calcium and aluminum in determining the fishery status of low pH lakes is complex, both ions will need to be considered in any attempt to explain the field observations. (Baker-IVI)
W84-01437

SURVIVAL AND CONDITION OF RAINBOW TROUT (SALMO GAIRDNERI) AFTER EXPOSURES TO METHYL PARATHION, TRIPHENYL PHOSPHATE, AND DEF,
Fish and Wildlife Service, Columbia, MO.
D. Palawski, D. R. Buckler, and F. L. Mayer.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 5, p 614-620, May, 1983. 3 Tab, 11 Ref.

*Organophosphates, *Fish, *Survival, Agricultural chemicals, Defoliants, Pesticides, Hydraulic fluids, Methyl parathion, DEF, Triphenyl phosphate, Toxicity.

Toxicity data was sought for DEF, an aliphatic organophosphate defoliant; methyl parathion, an aliphatic/aromatic organophosphate insecticide; and triphenyl phosphate, an aromatic organophosphtae combined with various phosphate esters in mixtures to form hydraulic fluids. The protocol used for this study was also evaluated for possible use in assessing the effects of chemical spills on aquatic resources. One hundred fish were exposed under static water conditions for 96 hr to each toxicant in 30-liter stainless steel tanks. After the 96 hr exposure, a maximum of 40 survivors per exposure were removed from the tanks, stocked in 45 liter stainless steel tanks and reacclimated to clean well water. The 96-hr LC50s were 0.36 mg/l for triphenyl phosphate; 0.31 mg/l for DEF; and 2.8 mg/l for methyl parathion. Results obtained after 96 hr of static exposure indicated that methyl parathion at concentrations of 2.1, 2.4, and 2.8 mh/l produced the most deleterious effects to rainbow trout, causing mortalities of 37%, 38%, and 61% respectively. All survivors in each concentration were immobile and had distended abdomens at the end of the static exposure. Ability of survivors to recover after exposure to methyl parathion was significantly impaired during the first day after transfer to clean water. After this critical period no further mortality was noted. Survival after exposure was 28% for fish exposed to 2.1 mg/l of methyl parathion, but only 2% for fish exposed to 2.8 mg/l. No significant increase was noted in mortality of rainbow trout during the observation period following exposure to triphenyl phosphate. A biological effect noted in about 12% of the survivors exposed to the highest concentration of triphenyl phosphate was possible vertebral damage in the caudal area, resulting in spinal curvatures. (Baker-IVI)
W84-01438

SHORT-TERM STANDING CROP AND DIVERSITY OF PERIPHYTIC DIATOMS IN A EUTROPHIC RESERVOIR,
K. D. Hoagland.
Journal of Phycology, Vol. 19, No. 1, p 30-38, March, 1983. 7 Fig, 6 Tab, 62 Ref. 14-34-0001-6028.

Descriptors: *Diatoms, *Standing crops, *Species diversity, Periphyton, Weather, Turbulence, Substrates, Attachment, Wave action, Colonization, Eutrophication, Reservoirs.

Adverse weather and resultant turbulence caused sloughing of attached diatom communities during the first two weeks of colonization on artificial substrates. In contrast to Pacific macroalgal systems, older communities (8-12 d) were the most affected by wave action. Ash-free dry weight of the periphyton and diatom cell density generally increased, except following periods of high turbulence when losses of up to 80% occurred. The maximum cell density (400,000 diatoms/sq cm) and ash-free dry weight (2.9 mg/sq cm) are among the highest reported for similar conditions. Percent transmittance through the growth layer correlated significantly with cell density and ash-free dry weight and is recommended as a rapid method for measuring the relative accumulation of periphyton. Diatom diversity generally increased throughout the study period and did not clearly reflect the effects of disturbance as did standing crop. Comparisons of diatom diversity and community composition indicated that the three overlapping growth series were not significantly different and samples collected on the same date were not more similar than those of identical age. Combined with previous evidence, the present study indicates that the first two weeks of substrate exposure in the summer represented a colonization phase followed by rapid microsuccession. (Author's abstract)
W84-01446

DISTRIBUTION OF HEMICELLULOSE-DECOMPOSING BACTERIA AND ENVIRONMENTAL CONDITIONS IN SEAWATER IN HIRO BAY,
Shimonoseki Univ. of Fisheries (Japan). Lab. of Microbiology.
M. Murakami, and H. Fujisawa.
Bulletin of the Japanese Society of Scientific Fisheries, Vol. 49, No. 3, p 455-462, March, 1983. 3 Fig, 3 Tab, 21 Ref.

Descriptors: *Pulp wastes, *Microbial degradation, *Hemicellulose, Heterotrophic bacteria, Effluent, Water pollution effects, Kraft mills, Seawater, Chemical oxygen demand, Marine environment, Hiro Bay, Japan.

On the coast of Hiro Bay in Seto Inland Sea, there is a kraft pulp mill whose effluent flows into the bay. Many workers have reported about organic pollutants and their influence on fishery in this area. Although microbiological work is indispensable for clarifying the mechanism of the decomposition of organic pollutants, little has been known about it. Therefore, a series of studies has been undertaken to clarify the microbial decomposition of hemicellulose in coastal waters polluted with pulp mill effluent. The distribution of heterotrophic bacteria and hemicellulose decomposing bacteria, and the environmental conditions of seawater in the above-mentioned area were investigated five times from 1979 to 1981. The results obtained can be summarized as follows: the population densities of heterotrophic bacteria, glucomannan-decomposing bacteria, xylan-decomposing bacteria and agar-decomposing bacteria per ml of seawater, were 100 to 10,000,000, 10 to 100,000, 10 to 10,000,000 and 10 to 100,000 respectively. The significance test of common coefficient regression analysis in the 1 m layer of seawater showed that the population density of bacteria and the value of COD decreased with the distance from pulp mill. The ratio of the population density of xylan-decomposing bacteria to the population density of heterotrophic bacteria in the 1 m layer of seawater was 10 to 1,000 times as high as that in the control area (Yoshimi Bay), and similar to that in other pulp mill polluted areas (Iwakuni waters). Therefore, it can be said that this ratio may be one of the suitable indices for the pollution from pulp mills. (Author's abstract)
W84-01455

A MODEL FOR THE DENSITY OF AEROMONAS HYDROPHILA IN ALBEMARLE SOUND, NORTH CAROLINA,
Puerto Rico Univ., Rio Piedras. Dept. of Biology.
T. C. Hazen.
Microbial Ecology, Vol. 9, No. 2, p 137-153, July, 1983. 8 Fig, 6 Tab, 35 Ref. RR-8102, 04F15844030, DE-AS09-76EY-0900.

Descriptors: *Aeromonas, *Mathematical models, *Water quality, Heterotrophic bacteria, Coliforms,Dissolved oxygen, Water temperature, Orthophosphate, Chlorophyll a, Kjeldahl nitrogen, Ammonia, Regression analysis, Epizootiology, Eutrophication, Reservoirs, Estuaries.

The abundance of Aeromonas hydrophila was measured monthly at 29 sites in Albemarle Sound, North Carolina and its tributaries from April 1977 through July 1979. Simultaneous measurements included heterotrophic plate count bacteria, fecal coliform bacteria, and 18 physical and chemical parameters. Using only 6 water quality parameters, multiple correlation and regression analysis of the data produced a best-fit regression which explained 38% of the variation observed in A. hydrophila density. The 6 water quality parameters included dissolved oxygen, temperature, orthophosphate, chlorophyll A trichromatic, total Kjeldahl nitrogen, and ammonia. Heterotrophic plate count bacteria and fecal coliform densities were highly correlated with A. hydrophila density, but made the model very unstable. The model was successfully tested against similar data collected for 2 other North Carolina reservoirs, Lake Norman and Badin Lake. Data from 10 sites in Badin Lake over 18 months and from 7 sites on Lake Norman over 5 months were not significantly different from the Albemarle Sound model. Conditions of water quality that may give rise to 'blooms' of A. hydrophila will simultaneously contribute to the probability of increased epizootics in fish in the southeastern United States. (Author's abstract)
W84-01473

CHANGES IN WATER AND SEDIMENT BACTERIAL COMMUNITY STRUCTURE IN A LAKE RECEIVING ACID MINE DRAINAGE,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
R. A. Wassel, and A. L. Mills.
Microbial Ecology, Vol. 9, No. 2, p 155-169, July, 1983. 2 Fig, 5 Tab, 39 Ref. DEB-7906298.

Descriptors: *Acid mine drainage, *Bacteria, *Water pollution effects, Biological communities, Heterotrophic bacteria, Heavy metals, Sediment bacteria, Species diversity.

Water and sediment bacterial communities in a freshwater impoundment were studied over a 13-month period for stress-related responses to a point source of acid mine drainage (AMD). Comparisons of community structure were made on collections taken at the mouth of the acid stream, at a point 2 km downstream, and at the mouth of an uncontaminated stream. Monthly measurements of pH and specific conductance indicated the expected decrease in the AMD pollution with increasing distance from the source. Acridine orange direct counts did not differ significantly among the sites; however significantly fewer viable heterotrophs were observed by plate counts at the acid impacted station relative to the uncontaminated site. The diversity of the communities was significantly lower at the sites receiving mine drainage as compared with the unaffected station, and comparisons of community similarity showed that collections from the impacted sites were more like each other than like the control site. The assemblage at the latter site contained many bacterial guilds not found at the contaminated sites. The guilds unique to the control site showed a reduced in vitro ability to tolerate heavy metals as compared with the general community. (Author's abstract)
W84-01474

INVESTIGATIONS ON THE INFLUENCE OF COASTAL UPWELLING AND POLLUTED RIVERS ON THE MICROFLORA OF THE NORTHEASTERN ATLANTIC OFF PORTUGAL; I. SIZE AND COMPOSITION OF THE BACTERIAL POPULATION,
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
G. Rheinheimer, and R. Schmaljohann.
Botanica Marina, Vol. 26, No. 3, p 137-152, March, 1983. 17 Fig, 3 Tab, 25 Ref.

Descriptors: *Eutrophication, *Bacteria, Upwelling, Marine environment, River flow, River mouth, Saprophytic bacteria.

Investigations conducted in May of 1981 off the western and southern coasts of Portugal indicate that upwelling dominated at this time throughout the area. Bacterial counts and biomass measurements were distinctly higher than in April of 1980. Bacteriological variables revealed differences between the northern and southern sections in accordance with the particular upwelling situations. Terrigenous influence proved to be restricted to the mouths of the rivers Douro and Tejo, and were evidenced through a rise in the numbers of saprophytes at the stations nearest the coast. Total bacterial counts exhibited only small differences compared to stations further offshore. The terrigenous influence was stronger in the the area of the mouth of the Tejo, where at a depth of 100 m, 1085 saprophytes/ml were counted. In general, total bacterial counts decreased with increasing depth, although in some cases an increase of bacterial numbers at depths of 500-1000 m was found. In certain locations the percentage of dividing cells in subsurface water layers was greater than at the surface. The distribution of a few morphologically distinguished groups of bacteria showed differences within the area of study and from other regions of the sea. (Moore-IVI)
W84-01475

SEWAGE POLLUTION AND THE INFAUNAL BENTHOS OF VICTORIA HARBOUR, HONG KONG,
Fisheries Research Station, Aberdeen (Hong Kong).
G. B. Thompson, and P. K. Shin.
Journal of Experimental Marine Biology and Ecology, Vol. 67, No. 3, p 279-299, March, 1983. 9 Fig, 5 Tab, 56 Ref.

Descriptors: *Water pollution effects, *Benthic fauna, *Wastewater pollution, Tidal currents, Harbors, Typhoon shelters, Abiotic areas, Polychaetes, Oligochaetes, Mollusks, Species diversity, Biomass, Biological communities, Hong Kong.

Victoria Harbor, Hong Kong, receives 800 million l/day of untreated sewage from 3.6 million people, but is flushed by tidal currents at velocities up to 1.1 m/s. Two replicate Smith-McIntyre grab samples were collected at 66 stations in August 1979, yielding a total of 5797 animals belonging to 68 species. Agglomerative hierarchical classification was used to delineate five station groups; a sixth group contained four stations where no fauna was found. All but one of the groups inhabited fine sediments (>70% silt-clay) and could be placed along a gradient conforming to the typical pattern of organic pollution effects found in boreal and temperate waters. Abiotic areas, found in enclosed typhoon shelters, were successively replaced by a very poor fauna, a peak of opportunists, an ecotone point and a transition to normal fauna. The peak of opportunists was dominated by the oligochaete Thalassodrilides gurwitschi (Hrabe); the polychaetes Capitella capitata (Fabricius) and Minuspio cirrifera (Wiren) were also numerous. Overall abundance was low (784 individuals/sq m) compared with opportunists in boreal and temperate waters. The remaining station group was found in coarser sediments (<40% silt-clay) and an inflection was observed in the log-normal distribution of individuals per species. Dominant species included the bivalve Tapes philippinarum (Adams and Reeve) and the polychaete M. cirrifera; overall abundance was high (1103 individuals/sq m). In general, pollution was assessed by the pattern of changes in number of species, abundance, biomass, diversity and evenness, by log-normal distributions of individuals per species, and by the indicator species M. cirrifera. When compared with earlier (1976) data, community conditions were generally similar but the abundance of individual species varied greatly and M. cirrifera was absent. The severely polluted area was about 15 sq km; this is similar in extent to offshore discharge sites and indicates the importance of tidal flushing in this inshore channel. (Author's abstract)
W84-01477

BIOCONCENTRATION OF CHLOROBENZENES FROM WATER BY RAINBOW TROUT: CORRELATIONS WITH PARTITION COEFFICIENTS AND ENVIRONMENTAL RESIDUES,
B. G. Oliver, and A. J. Niimi.
Environmental Science Technology, Vol. 17, No. 5, p 287-291, May, 1983. 1 Fig, 3 Tab, 25 Ref.

Descriptors: *Biological magnification, *Chlorinated hydrocarbons, *Benzenes, *Trout, Hexachlorobutadiene, Hexachloroethane, Lake Ontario, Partition.

The bioconcentration by rainbown trout of ten chlorobenzenes (CB's), hexachlorobutadiene (HCBD), and hexachloroethane (HCE) at water concentrations near environmental levels (nanograms per liter range) has been studied. The bioconcentration factor (BCF) for the CB's was found to increase dramatically as the degree of chlorine substitution on the aromatic ring became greater. There was a high correlation between the BCF and the octanol water partition coefficient for HCBD, HCE, and all the chlorobenzenes except hexachlorobenzene (HCB). Ten adult rainbow trout from Lake Ontario were analyzed for these contaminants. Then, with use of field values for contaminant concentrations in water and laboratory values for BCF's, predictions of field concentrations in fish (on the basis of accumulation from water only) were made. These values were then compared to the fish field data. (Author's abstract)
W84-01501

GILL SURFACE INTERACTION MODEL FOR TRACE-METAL TOXICITY TO FISHES: ROLE OF COMPLEXATION, PH, AND WATER HARDNESS,
Montana State Univ., Bozeman. Dept. of Chemistry.
G. K. Pagenkopf.
Environmental Science and Technology, Vol. 17, No. 6, p 342-347, June, 1983. 6 Tab, 40 Ref.

Descriptors: *Toxicity, *Trace metals, *Fish, Alkalinity, Hardness, Hydrogen ion concentration,

Copper, Cadmium, Lead, Zinc, Mathematical models.

A model has been developed to account for the variability in trace-metal toxicity to fishes at different values of alkalinity, hardness, and pH. The model utilizes trace-metal speciation, gill surface interaction, and competitive inhibition to predict effective toxicant concentration (ETC). Copper, cadmium, lead, and zinc bioassay data have been utilized. (Author's abstract)
W84-01503

SEASONAL VARIATION OF CADMIUM TOXICITY TOWARD THE ALGA SELENASTRUM CAPRICORNUTUM PRINTZ IN TWO LAKES WITH DIFFERENT HUMUS CONTENT,
Oslo Univ. (Norway). Inst. for Kjemi.
M. Laegreid, J. Alstad, D. Klaveness, and H. M. Selp.
Environmental Science and Technology, Vol. 17, No. 6, p 357-361, June, 1983. 5 Fig, 1 Tab, 29 Ref.

Descriptors: *Cadmium, *Toxicity, *Organic matter, Selenastrum, Chlorophyta, Eutrophication, Seasonal variation, Ions, Decomposing organic matter, Dissolved solids.

The alga Selenastrum capricornutum Printz is used to investigate the potential of natural lake water to reduce cadmium toxicity. The two lakes involved differ in trophic status and in concentration and composition of dissolved organic matter, one being a typical dystrophic bog lake, the other a less humus influenced, eutrophic lake. In the dystrophic lake, the toxic effect is determined mainly by the free cadmium activity. In the eutrophic, less humus influenced lake, however, the toxic effect shows considerable seasonal variations with a toxicity far exceeding what would be expected according to the estimated free ion activity during summer. It is hypothesized that qualitative changes in the composition of the dissolved organic matter during the production period are responsible for this effect. (Author's abstract)
W84-01504

ACID DEPOSITION AND FOREST DECLINE,
A. H. Johnson, and T. G. Siccama.
Environmental Science and Technology, Vol. 17, No. 7, p 294-305, July, 1983. 13 Fig, 1 Tab, 55 Ref. APP-0108-1982, APP-0099-1981.

Descriptors: *Acid rain, *Water pollution effects, *Forests, Forest management, Vegetation, Drought, Spruce, Trace metals.

Red spruce in the high elevation forests of New York, Vermont, and New Hampshire has shown marked dieback and a very large reduction in basal area and density over the past 15-20 years. Similar problems were noted in West Germany. In both countries the affected forests are located in areas that receive large atmospheric inputs of acidic substances and other pollutants. The location, topography and other characteristics of these forests cause them to be receptors of high levels of acid deposition and airborne trace metals. Several possible pathways exist by which acid deposition could contribute to spruce mortality. Evidence regarding a triggering effect of droughts is being substantiated. However, whether drought is sufficient to cause the dieback or whether there is additional stress from pollution is not clear. The possibility of multiple stresses is considered. Drought following by infection by secondary organisms appears likely. Acid deposits could enhance drought stress or vice versa. (Baker-IVI)
W84-01506

LEVELS OF ORGANIC POLLUTION IN COASTAL LAGOONS OF TABASCO STATE, MEXICO; I: PETROLEUM HYDROCARBONS,
A. V. Botello, J. A. Goni, and S. A. Castro.
Bulletin of Environmental Contamination and Toxicology, Vol. 31, No. 3, p 217-277, September, 1983. 5 Fig, 2 Tab, 10 Ref.

Descriptors: *Hydrocarbons, *Oil pollution, *Lagoons, Coastal areas, Sediments, Oysters, Bioaccumulation, Oil spills, Storms, Oil industry, Tabasco, Mexico.

More than 100 samples of sediments and oysters (Crassostrea virginica) were collected at 27 stations located in the Carmen-Machona and Mecoacan lagoons in Tabasco, Mexico, during four periods: October, 1979; January, March, and May, 1980. The majority of values obtained for total hydrocarbon concentrations in sediments are below 70 ppm; they correspond to hydrocarbon concentrations in coastal areas considered to be non-polluted. The highest concentrations (1060 and 305 ppm) reflect the influence of oil spilled in the Ixtoc-I accident, which was carried to the coast by tropical storm 'Henry' in September, 1979. The remaining values between 80 and 150 ppm (18%) are probably due to fluvial discharges and runoff from adjacent areas where exploration, exploitation and crude oil refinement are carried out. The results obtained in May are all less than 70 ppm, which could indicate that fossil hydrocarbons do not remain in the sediments of the lagoon studied because of the great dynamism of the coastal ecosystems. The results obtained for oysters coincide with those reported for bivalves from lagoons, bays and canals affected by oil industry activities and accidents. The greatest concentrations of hydrocarbons in oysters were observed principally in October, which may indicate that these organisms had bioaccumulated compounds or adsorbed particles of oil from the Ixtoc-I accident. In general, the values obtained for oysters indicate chronic pollution. (Moore-IVI)
W84-01585

ACUTE TOXICITY OF CHLORINE AND BROMINE TO FATHEAD MINNOWS AND BLUEGILLS,
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Lab.
E. W. Wilde, R. J. Soracco, L. A. Mayack, R. L. Shealy, and T. L. Broadwell.
Bulletin of Environmental Contamination and Toxicology, Vol. 31, No. 3, p 309-314, September, 1983. 2 Tab, 19 Ref. DE-AC09-76SR00001.

Descriptors: *Chlorination, *Biocides, *Toxicity, *Bromine, Fish, Cooling water, Antifouling agents, Residual chlorine, Residual bromine, Fathead minnows, Bluegills.

Several alternatives to chlorination have recently been proposed including the use of a bromine-based biocide, 1-bromo-3-chloro-5,5-dimethylhydantoin (BCDMH). The relative toxicity of chlorine and BCDMH to three types of fish were compared in a freshwater system used for cooling a nuclear reactor. Flow-through 96-hr toxicity tests were conducted using water from Par Pond, a reactor cooling reservoir at the Savannah River Plant near Aiken, S.C. Juvenile and yearling fathead minnows and young-of-the-year bluegills were used as test organisms. Median lethal concentrations for total residual chlorine (TRC) and total residual bromine (TRB) were statistically compared. Juvenile fathead minnows were significantly more tolerant of TRB than TRC. TRC and TRB 96-hr median lethal concentrations for adult fathead minnows were not significantly different. Bluegills were significantly more tolerant of TRC than TRB. Bluegills were significantly more tolerant of both biocides than were fathead minnows. Adult minnows were significantly more tolerant of both biocides than juvenile minnows. (Moore-IVI)
W84-01586

COMPARATIVE STUDY OF THE EFFECTS OF METALS ON THE SETTLEMENT OF CRASSOSTREA GIGAS,
Port Elizabeth Univ. (South Africa). Dept. of Zoology.
H. R. Watling.
Bulletin of Environmental Contamination and Toxicology, Vol. 31, No. 3, p 344-351, September, 1983. 2 Fig, 3 Tab, 9 Ref.

Descriptors: *Oysters, *Heavy metals, *Water pollution effects, *Larvae, Growth stages, Zinc, Cadmium, Copper, Lead, Manganese, Nickel, Cobalt, Chromium, Spat, Behavior, Mortality.

The effects of eight elements on Crassostrea gigas larval settlement and spat growth have been investigated using a single larval culture for each comparative test. The metal concentrations were chosen in the range to cause sub-lethal rather than lethal effects. Zinc, cadmium, copper, lead, manganese, nickel, cobalt, and chromium were tested at 10 and 20 micro g/l. Experimental observations included growth and behavior in addition to mortality. Of the eight elements studied, only copper and manganese were not detrimental to C. gigas settlement success. Larval behavior was not noticeable different for the various treatments in this experiment. Zinc and lead delayed settlement, and copper and cobalt induced early settlement. Zinc, cadmium, copper, lead, manganese, nickel, cobalt and chromium in the 10-20 micro g/l range all caused a reduction in spat growth during metal exposure. Low copper concentrations (20-40 micro g/l), added to the water immediately prior to larval settlement and for only two or three days may stimulate larval settlement. (Moore-IVI)
W84-01588

COMPARATIVE BIOACCUMULATION AND ELIMINATION OF HCH ISOMERS IN SHORT-NECKED CLAM (VENERUPIS JAPONICA) AND GUPPY (POECILIA RETICULATA),
Moji Public Health Center (Japan).
Y. Yamato, M. Kiyonaga, and T. Watanabe.
Bulletin of Environmental Contamination and Toxicology, Vol. 31, No. 3, p 352-359, September, 1983. 4 Fig, 1 Tab, 11 Ref.

Descriptors: *Bioaccumulation, *Pesticide residues, *Elimination, Insecticides, Guppy, Clam, HCH, Lindane, Chlorinated hydrocarbons.

In Japan, HCH had been one of the most applied insecticides to arable fields, especially to rice paddies. Residues of alpha, beta, and delta HCH have been detected as well as insecticidally active gamma HCH in the environment because technical grade HCH had been formulated and marketed as HCH insecticide. Comparative bioaccumulation and elimination of 4 HCH isomers by short-necked clam (Venerupis japonica) and guppy (Poecilia reticulata) were examined. Alpha, beta, gamma, and delta HCH were dissolved in water at concentrations of 1, 2, 1, and 2 ppb, respectively and the clams or guppies were exposed for 10 days, and then removed to HCH-free flowing water. The guppy rapidly bioaccumulated HCH isomers and the concentrations reached a plateau on the 4th day. The bioaccumulation ratios (BR) of alpha, beta, gamma, and delta HCH were 706, 1043, 697, and 648 times on that day, respectively. Concentrations of HCH isomers in the guppy smoothly decreased on the first day after replacement to HCH-free water, and constantly declined afterwards. Short-necked clams rapidly absorbed HCH isomers, and the concentrations reached a plateau on day three. The BR of alpha, beta, gamma, and delta HCH were 161, 127, 121, and 272 times, respectively. Concentrations of each HCH isomer in clams constantly decreased after replacement to HCH-free water. (Moore-IVI)
W84-01589

CHRONIC TOXICITY TO FATHEAD MINNOW PIMEPHALES PROMELAS OF WASTEWATER FROM A CONVENTIONAL WASTEWATER TREATMENT SYSTEM RECEIVING ORGANIC PRIORITY POLLUTANTS,
Environmental Research Lab.-Duluth, Cincinnati, OH. Newtown Fish Toxicology Station.
Q. H. Pickering.
Environmental Pollution (Series A), Vol. 31, No. 3, p 105-117, June, 1983. 4 Tab, 17 Ref.

Descriptors: *Effluent, *Toxicity, Fathead minnows, Chlorination, Hatching, Growth, Larval growth stages, Wastewater treatment, Organic compounds, Priority pollutants, Mortality.

Chronic toxicity tests were made with unchlorinated and dechlorinated effluent from a conventional wastewater treatment system receiving 22 organic

priority pollutants. The early-life-stage (ELS) tests began with fathead minnow embryos less than 1-day old and exposure continued for 30 days post hatch. There was no significant difference in hatchability between any effluent concentration (5.0-0.16%) and control. Survival and growth of larvae-juveniles in all unchlorinated concentrations were similar to controls. The chronic value for this exposure was > 5% and the acute-chronic ratio was < 6.6. Survival and growth of fish in 5% dechlorinated effluent were significantly less than survival and growth of control fish. Survival of fish in the 2.5% effluent was similar to survival of control fish. However, growth of these fish was only 75% of control fish and was significantly less than growth of control fish. Survival and growth of fish in the 1.3% effluent were not different from controls. The chronic value of the dechlorinated effluent was 1.8% and the acute-chronic ratio, about 19.
W84-01591

A NOTE ON THE EFFECTS OF CRUDE OIL ON MICROBIAL ACTIVITIES IN A STREAM SEDIMENT,
Oregon State Univ., Corvallis. Dept. of Microbiology.
J. H. Baker, and R. Y. Morita.
Environmental Pollution (Series A), Vol. 31, No. 2, p 149-157, June, 1983. 1 Fig, 1 Tab, 15 Ref. NOAA Contract 03-05-022-68.

Descriptors: *Oil pollution, *Stream sediments, *Microorganisms, Metabolism, Nitrogen fixation, Carbon dioxide, Methanogenesis, Phosphatase, Mud, Hydrocarbons.

Rivers are the most important transport systems for hydrocarbon wastes which may arise from both accidental spills and controlled effluents. However, the influence of crude oil on normal metabolic processes occurring in river sediments has been largely neglected. The work described was a pilot study designed to demonstrate the effects of spilled oil on a wide range of microbial activities in a stream mud. The stream chosen was Berry Creek, a controlled minor tributary of the Willamette watershed in western Oregon. Rates of CO2 production, nitrogen fixation and methanogenesis, Vmax for glucose, and phosphatase levels were all determined in the presence and absence of crude oil. Four weeks after the oil addition the Vmax and phosphatase levels were significantly reduced and remained so, but methane and CO2 production rates were both significantly increased. Nitrogen fixation was not affected by 0.1% (v/v) oil, but was reduced after 8 weeks by 1.0% oil.
W84-01592

ACUTE TOXICITY OF A DITHIOCARBAMATE FUNGICIDE, THIRAM, WITH REGARD TO SEVERAL SPECIES OF FRESHWATER ANIMALS (TOXICITE AIGUE D'UN FONGICIDE DITHIOCARBAMATE, LE THIRAME, VIS A VIS DE PLUSIEURS ESPECES ANIMALES D'EAU DOUCE),
Paris-11 Univ., Orsay (France). Lab. de Zoologie.
J. Seuge, D. Marchal-Segualt, and R. Bluzat.
Environmental Pollution (Series A), Vol. 31, No. 3, p 177-189, July, 1983. 2 Fig, 2 Tab, 16 Ref.

Descriptors: *Toxicity, *Thiram, Fungicides, Mollusks, Amphibians, Crustacea, Insects, Platyhelminths.

Acute toxicity experiments (24, 48, 72 and 96 h) were carried out with an aqueous suspension of thiram (commercial powder titered at 80%). The animal sensitivity was very variable, the 24-h and 96-h LC50's being 0.53 ppm and 0.048 ppm (Dugesia gonocephala, plathelminth), 1882 ppm and 61 ppm (Asellus aquaticus, crustacean), 0.017 ppm and 0.013 ppm (Xenopus laevis, amphibian, stage 47), 0.025 ppm and 0.021 ppm (Xenopus, stage 53). In all cases, the LC50 related to time can be described by the law y = axb; this permitted us to compare the present results with those already obtained in Lymnaea stagnalis (molluscan), Gammarus pulex (crustacean) and larvae of Cloeon dipterum (insect). The slopes of these curves indicate three types of reaction: one in the two crustaceans (Asellus and Gammarus), one in Lymnaea and Dugesia and one in Cloeon and Xenopus larvae. The six species studied can be classified according to increasing sensitivity as follows: Asellus, Lymnaea, Gammarus and Cloeon larvae at the same level, Dugesia and Xenopus larvae; the spectrum of thiram activity is in the range 10 pptm to 5000-6000ppm: it is then very large. It can be concluded that thiram, a fungicide intensively used in agriculture, presents a real threat to all freshwater fauna. (Author's abstract)
W84-01593

TOXICITY, ACCUMULTION AND CLEARANCE OF AROMATIC HYDROCARBONS IN DAPHNIA PULEX,
Ottawa Univ. (Ontario). Dept. of Biology.
R. G. Trucco, F. R. Engelhardt, and B. Stacey.
Environmental Pollution (Series A), Vol. 31, No. 3, p 191-202, July, 1983. 1 Fig, 3 Tab, 17 Ref.

Descriptors: *Hydrocarbons, *Toxicity, *Bioaccumulation, Daphnia, Metabolism, Benzene, Naphthalene, Phenanthrene, Benzo(a)anthracene, Benzo(a)pyrene.

Exposure of the zooplankter Daphnia pulex to five aromatic hydrocarbons in water determined an increasing toxicity in the order of benzene, naphthalene, phenanthrene, benzo(a)anthracene to benzo(a)pyrene, as measured by 96-h LC50 values. These ranged exponentially from 15 mg/l for benzene to 5 micro g/l for benzo(a)pyrene. Accumulation after 24 h of exposure was found to be specific to the aromatic hydrocarbon, measured as 14C-aromatic hydrocarbon load, as well as to the vector of exposure. Naphthalene accumulation was greatest, about 11 thousand times from algal food, while benzo(a)anthracene and benzo(a)pyrene accumulated more from the water, about one and three thousand times, respectively. Benzene was least accumulated. Clearance of the accumulated aromatic hydrocarbons occurred rapidly in all cases but naphthalene. Naphthalene clearance by 72 h after cessation of exposure was only 17 to 30% of the 24-h hoad, while the other four hydrocarbons were cleared by an average of 85%. (Author's abstract)
W84-01594

ALKYL LEAD POLLUTION AND BIRD MORTALITIES ON THE MERSEY ESTUARY, UK, 1979-1981,
Institute of Terrestrial Ecology, Huntingdon (England). Monks Wood Experimental Station.
K. R. Bull, W. J. Every, P. Freestone, J. R. Hall, and D. Osborn.
Environmental Pollution (Series A), Vol. 31, No. 3, p 239-259, August, 1983. 2 Fig, 5 Tab, 17 Ref.

Descriptors: *Birds, *Mortality, *Trialkyl lead, Organolead compounds, Waterfowl, Toxicity, Invertebrates, Industrial wastes, Chemical industry, Estuaries, Mersey Estuary, England.

In autumn 1979 about 2400 birds of many species were found dead and sick on the Mersey Estuary, UK, which is an important wader and wildfowl wintering area. Smaller mortalities occurred in 1980 and 1981. Affected birds contained elevated lead levels, much of the lead being in the form of alkyl lead. Apparently healthy birds contained lower amounts of alkyl lead but still enough to cause some ill-effects. Trialkyl lead compounds (on the order of 80 kg/day) were discharged into the Mersey-Manchester Ship Canal system from petrochemical works at levels which would account for the levels found in invertebrates on which the birds could feed. Such concentrations in invertebrates could easily lead to birds accumulating the levels of trialkyl lead found in their tissues. Several thousand apparently healthy birds were apparently also at risk. (Moore-IVI)
W84-01595

MALATHION INDUCED HEMATOLOGICAL AND BIOCHEMICAL CHANGES IN THE INDIAN CATFISH HETEROPNEUSTES FOSSILIS,
Gorakhpur Univ. (India). Dept. of Zoology.
J. Mishra, and A. K. Srivastava.
Environmental Research, Vol. 30, No. 2, p 393-398, April, 1983. 3 Tab, 33 Ref.

Descriptors: *Toxicity, *Malathion, *Catfish, Pesticides, Metabolism, Chloride, Blood, Pathology.

The acute toxicity and effects of duration of sublethal exposure to malathion were determined in the Indian catfish (Heteropneusters fossilis). Fish exposed to the pesticide for 2, 6, 12, 48, and 96 hr showed muscle glycogenolysis with concomitant hyperglycemia at all intervals; hepatic glycogen was unaffected. Malathion was also associated with hypochloremia at 2 and 6 hr and hyperchloremia at 48 and 96 hr; blood chloride concentration was unaffected at 12 hr. Fish developed erythropenia and leukopenia; lowered hematocrit and hemoglobin content and hypercoagulability of blood were also observed. The data showed that homeostatic and hemostatic mechanisms are disturbed after malathion treatment and could be helpful for evaluating pesticide toxicosis in fish. (Author's abstract)
W84-01601

ANALYSIS OF THE EFFECT OF INDUSTRIAL EFFLUENT ON PIGMENTS, PROTEINS, NUCLEIC ACIDS, AND THE 2,6-DICHLOROPHENOL INDOPHENOL HILL REACTION OF RICE SEEDLINGS,
Indian Inst. of Tech., New Delhi. Centre for Biomedical Engineering.
B. K. Behera, and B. N. Misra.
Environmental Research, Vol. 31, No. 2, p 381-389, August, 1983. 7 Fig, 16 Ref.

Descriptors: *Industrial wastewater, *Plant pathology, Effluent, Rice, Seedlings, Nucleic acids, Chlorophyll, Pigments, Food-processing wastes.

The effect of an effluent from a distillery of a sugar factory on cellular macromolecular composition and indophenol photochemical activity of isolated chloroplasts of rice (Orvza sativa c.v. Mushoori) seedlings was investigated. The effluent, which is known as spend wash, contains high concentrations of various cations and anions. The total pigments, proteins, and nucleic acids of rice seedlings declined with an increase in effluent concentration and the time of incubation. The loss in contents of macromolecules like deoxyribonucleic acid (DNA), ribonucleic acid (RNA), and protein was relatively more marked in the root than in the shoot. RNA and chlorophyll (Chl) contents of the seedlings were found most susceptible to effluent stress. Loss in Hill reaction activity measured as photoreduction of 2,6-dichlorophenol indophenol (DCPIP) of isolated chloroplasts could be correlated in a general way with the loss of pigments, proteins and nucleic acids. Diphenyl carbazide-induced and Mn(2+)-induced restoration of loss in DCPIP photoreduction suggests that the damage of oxygen evolving systems is the initial site of action of the effluent. (Moore-IVI)
W84-01602

PESTICIDE-INDUCED DYSFUNCTION IN CARBOHYDRATE METABOLISM IN THREE FRESHWATER FISHES,
D.A.V. Coll., Muzaffarnagar (India). Pollution Relevant Research Lab.
S. R. Verma, S. Rani, I. P. Tonk, and R. C. Dalela.
Environmental Research, Vol. 32, No. 1, p 127-133, October, 1983. 3 Tab, 31 Ref.

Descriptors: *Toxicity, *Metabolism, *Pesticides, *Fish, Thiotox, Dichlorvos, Organophosphorus pesticides, Chlorinated hydrocarbon pesticides, Blood, Liver, Muscle.

The effect of sublethal fractions (1/4th, 1/8th and 1/16th of 96-hr LC50) of thiotox and dichlorvos on blood glucose, lactate, and liver and muscle glycogen levels of Clarias batrachus, Saccobranchus fossilis, and Mystus vittatus, exposed for 30 days, have been studied. Blood glucose and lactate levels increased from 29.13 to 98.36% and from 10.88 to 36.36%, respectively. The liver and muscle glycogen decreased from 22.99 to 69.30% and from 5.19 to 32.19%, respectively. This carbo-

hydrate imbalance may be a result of weaker cortisol influence and gluconeogenesis, enhanced glycogen breakdown, increased adrenocorticotropic hormone secretion, or an imbalance in insulin resulting from structural damage to the pancreas. (Moore-IVI)
W84-01603

NEUROLOGIC EVALUATION OF A POPULATION EXPOSED TO ARSENIC IN ALASKAN WELL WATER,
Centers for Disease Control, Atlanta, GA. Center for Environmental Health.
K. Kreiss, M. M. Zack, R. G. Feldman, C. A. Niles, and J. Chirico-Post.
Archives of Environmental Health, Vol. 38, No. 2, p 116-121, March-April, 1983. 4 Tab, 23 Ref.

Descriptors: *Arsenic, *Toxicity, *Drinking water, *Human pathology, Well water, Neuropathy, Heavy metals, Ester Dome, Alaska.

High levels of arsenic in well water and in biologic samples have previously been found for residents in Ester Dome, Alaska, a residential area just outside of Fairbanks. One hundred forty-seven persons exposed to arsenic from well water were evaluated by neurologic examination and nerve conduction studies. Total arsenic concentrations in well water ranged from 1 to 4781 micro g/L and from 6 to 4964 micro g/L in urine; a calculated index of arsenic ingestion ranged from 1 to 4521 micro g/day. No dose-response relationship existed between arsenic ingestion and symptoms or physical findings compatible with peripheral neuropathy. Five of six persons with symptoms or physical findings suggestive of sensory neuropathy had normal nerve conduction velocities. Thirteen persons with elevated arsenic ingestion but no signs or symptoms or neuropathy had one or more abnormal nerve conduction velocities. No dose-response relationship, however, existed between arsenic ingestion and nerve conduction velocities. Arsenic ingestion from well water at the concentrations found in this Alaskan community apparently did not result in clinical or subclinical neuropathy. (Moore-IVI)
W84-01604

COMPARATIVE ACUTE TOXICITIES OF SURFACTANTS TO AQUATIC INVERTEBRATES,
Procter and Gamble Co., Cincinnati, OH.
M. A. Lewis, and D. Suprenant.
Ecotoxicology and Environmental Safety, Vol. 7, No. 3, p 313-322, June, 1983. 1 Fig, 4 Tab, 29 Ref.

Descriptors: *Toxicity, *Surfactants, *Invertebrates, *Daphnia, Dero, Asellus, Dugesia, Rhabditis, Gammarus.

Investigations of the toxicity of surfactants to aquatic invertebrates have been limited primarily to determining the effects on a few species. The 48-hr LC50 values for three surfactants are reported for six species of aquatic invertebrates. The acute toxicities for each surfactant (mg/l) varied 159 to 580 x and were as follows: C11.8LAS (anionic), 1.7 (Dero sp.) to 270 (Asellus sp.); C14-15 alkylethoxylate (nonionic), 1.0 (Dugesia sp.) to 6.8 (Rhabditis sp.); CTAC (cationic), 0.1 (Gammarus sp.) to 587 (Asellus sp.). When compared to previously developed data, Daphnia magna was typically found to be the most sensitive of all species tested, including fish, to the surfactants. The use of D. magna in screening toxicity tests will provide a conservative estimate of surfactant toxicity for aquatic invertebrates and also for bluegill and fathead minnows. (Moore-IVI)
W84-01608

ACID RAIN: FILTERING OUT THE FACTS,
M. Pratt.
Agricultural Engineering, Vol. 64, No. 5, p 7-9, May, 1983. 2 Fig.

Descriptors: *Acid rain, *Reviews, United States, Europe, Canada, Water pollution sources, Acidity, Monitoring, Environmental effects.

One problem confronting the researcher examining the problem of acid rain is the lack of essential records much before the mid-sixties. Descriptions of 19th and early 20th century industrial operations both in the United States and Europe suggest a higher level of polluted air and water than would be tolerated now. A pH of 5.6 is considered normal. Rain and snow in particularly vulnerable areas may consistently measure less than 4.5 pH. The disposition of atmospheric contaminants occurs from two related atmospheric processes often identified as rainout and washout. A plan has been proposed where Canada and the US will have a permanent acid deposition measurement system with specific monitors strategically placed. With the usual systems for monitoring rain, only cations and anions can be measured, but not trace elements. The application of limestone to acidified lakes and streams requires considerable knowledge both of input sources to the lake and of water turnover times. Liming tends to increase aluminum and cadmium accumulations in waters with 4-6 pH levels, thus intensifying the likelihood of fish kills. While electric utilities often are cited as the major contributor to the problem, seldom does one hear of that industries contributions toward research funding to solve the problem. Without accurate long-term monitoring data, researcher have had to calculate acidity trends in presumably vulnerable areas. At times they may have had to assume that forest, crop and fish kills came from acid rain as they had no way to assess other factors such as whether some soils and waters in specific areas have ever consistently supported certain crops and certain types of aquatic life. (Baker-IVI)
W84-01610

STUDIES OF A SPRING PHYTOPLANKTON BLOOM IN AN ENCLOSED EXPERIMENTAL ECOSYSTEM. I. BIOCHEMICAL CHANGES IN RELATION TO THE NUTRIENT CHEMISTRY OF WATER,
Institute of Oceanographic Sciences, Wormley (England).
R. J. Morris, M. J. McCartney, and G. A. Robinson.
Journal of Experimental Marine Biology and Ecology, Vol. 70, No. 3, p 249-262, August, 1983. 7 Fig, 2 Tab, 57 Ref.

Descriptors: *Diatoms, *Eutrophication, *Nutrients, Lochs, Biochemistry, Species composition, Decomposition, Metabolism, Coastal waters, Loch Ewe, Scotland.

A spring bloom of diatoms which occurred in large enclosed ecosystem bags at Loch Ewe, Scotland, during 1980, has been the subject of a chemical study. Changes observed in the general biochemical composition of the diatoms during the bloom are compared with the species distribution and changes in the nutrient chemistry of the bag water. The results indicate that major changes in cell biochemistry are associated with the growth, development, and decay of a diatom bloom, particularly if one or more nutrients become limiting. Of particular note is the growth of carbohydrate levels in the cells when lipid and protein levels fall and the apparent shift in lipid metabolism from mainly non-polar lipids at the onset of growth to more polar lipids as the bloom proceeds, then back to less polar lipids as phosphate becomes limiting. (Moore-IVI)
W84-01642

MICROBIOLOGICAL SURVEY OF ADIRONDACK LAKES WITH VARIOUS PH VALUES,
Rensselaer Polytechnic Inst., Troy, NY. Dept. of Biology.
C. W. Boylen, M. O. Shick, D. A. Roberts, and R. Singer.
Applied and Environmental Microbiology, Vol. 45 No. 5, p 1538-1544, May, 1983. 5 Fig, 3 Tab, 35 Ref.

Descriptors: *Microorganisms, *Hydrogen ion concentration, *Oligotrophic lakes, *Bacteria, Adaptation, Heterotrophic bacteria, Acid rain, Adirondack lakes, New York.

Atmospheric acidic deposition has not been well described in terms of its effects on aquatic microbial populations. Many of the lakes in the Adirondack region of New York State are particularly sensitive to high H(+) inputs from acidic deposition. It is important that these ecosystems be examined so that future changes can be appraised. Nine high-altitude oligotrophic Adirondack lakes having water of pH 4.3 to 7.0 were surveyed for total bacterial numbers and possible adaptation of the microbial communities to enviromental pH. The number of heterotrophic bacteria from water samples recoverable on standard plate count agar were low (10 to 1000 per ml) for most of the lakes. Acridine orange direct counts were approximately two orders of magnitude higher than plate counts for each lake. Sediment aerobic heterotrophs recovered on standard plate count agar ranged from 14000 to 1,300,000 per g of sediment. Direct epifluorescence counts of bacteria in sediment samples ranged from 3,000,000 to 1.4 x 10 to the 7th power per g. Low density values were consistent with the oligotrophic nature of all the lakes surveyed. There were no apparent differences in numbers of bacteria originally isolated at pH 5.0 and pH 7.0 between circumneutral lakes (pH > 6.0) and acidic lakes (pH < 5.0). Approximately 1,200 isolates were recultured over a range of pH from 3.0 to 7.0. Regardless of the original isolation pH (pH 5.0 or pH 7.0), less than 10% of the isolates grew at pH < 5.0. Those originally isolated at pH 5.0 also grew at pH 6.0 and 7.0. Those originally isolated at pH 7.0 preferred pH 7.0, with 98% able to grow at pH 6.0 and 44% able to grow at pH 5.0. A chi-square contingency test clearly showed ($P < 0.005$) that two distinct heterotrophic populations had been originally isolated at pH 5.0 and pH 7.0, although there is undoubtedly some overlap between the two populations. (Moore-IVI)
W84-01654

EFFECTS OF METALS ON METHANOGENESIS, SULFATE REDUCTION, CARBON DIOXIDE EVOLUTION, AND MICROBIAL BIOMASS IN ANOXIC SALT MARSH SEDIMENTS,
State Univ. of New York at Stony Brook. Marine Sciences Research Center.
D. G. Capone, D. D. Reese, and R. P. Kiene.
Applied and Environmental Microbiology, Vol. 45, No. 5, p 1586-1591, May, 1983. 1 Fig, 2 Tab, 25 Ref. NOAA grant NA-80-RAD-00057, EPA grant R-809475-01-0, NSF grant OCE-82-00157.

Descriptors: *Salt marshes, *Sediments, *Microorganisms, *Heavy metals, *Anaerobic conditions, *Metabolism, Methane production, Carbon dioxide, Sulfates, Water pollution effects.

The effects of several metals on microbial methane, carbon dioxide, and sulfide production and microbial ATP were examined in sediments from Spartina alterniflora communities. Anaerobically homogenized sediments were amended with 1,000 ppm (ratio of weight of metal to dry weight of sediment) of various metals. Time courses in controls were similar for CH4, H2S, and CO2, with short initial lags (0 to 4 h) followed by periods of constant gas production (1 to 2 days) and declining rates thereafter. Comparisons were made between control and experimental assays with respect to initials rates of production (after lag) and overall production. Methane evolution was inhibited both initially and overall by CH3HgCl, HgS, and NaAsO2. A period of initial inhibition was followed by a period of overall stimulation with Hg, Pb, Ni, Cd, and Cu, all as chlorides, and with ZnSO4, K2CrO4, and K2Cr2O7. Production of CO2 was generally less affected by the addition of metals. Inhibition was noted with NaAsO2, CH3HgCl, and Na2MoO4. Minor stimulation of CO2 production occurred over the long term with chlorides of Hg, Pb, and Fe. Sulfate reduction was inhibited in the short term by all metals tested and over the long term by all but FeCl2 and NiCl2. Microbial biomass was decreased by FeCl2, K2Cr2O7, ZnSO4, CdCl2, and CuCl2 but remained generally unaffected by PbCl2, HgCl2, and NiCl2. Although the majority of metals produced an immediate inhibition of methanogenesis, for several metals this was only a transient phenomenon followed by an overall stimulation. The initial suppression of methanogenesis may be relieved by precipitation, complexation, or transformation of

the metal (possibly by methylation), with the subsequent stimulation resulting from a sustained inhibition of competing organisms (e.g., sulfate-reducing bacteria). For several environmentally significant metals, severe metal pollution may substantially alter the flow of carbon in sediments. (Author's abstract)
W84-01656

REPORT ON EUTROPHICATION STUDIES IN THE U.S.S.R.,
Moscow State Univ. (USSR). Dept. of General Ecology and Hydrobiology.
A. M. Ghilarov.
Water Resources, Vol. 17, No. 6, p 607-611, June, 1983. 39 Ref.

Descriptors: *Eutrophication, *USSR, *Nutrients, Pollution load, Municipal wastewater, Nonpoint pollution sources, Cyanophyta, Reservoirs, Mathematical models, Prediction, Phytoplankton, Biomass recovery.

Some results of eutrophication studies in the USSR are briefly reviewed. There are many lakes and man-made reservoirs in the USSR that show symptoms of eutrophication caused mainly by increasing nutrient loading from agricultural land and from municipal wastes. Especially strong eutrophication and heavy blooms of Cyanophyta occur in Dnieper-impounding reservoirs. Eutrophication has not yet touched such large Asian lakes as Issyk-Kul and Baikal, the water quality of which is controlled by special governmental decisions. The enormous number of different freshwater bodies located in various natural zones and in the regions with different human influence makes the forecasting of eutrophication important. Mathematical modeling of eutrophication is being developed in the USSR, along with other methods for the prediction of eutrophication. Although eutrophication most frequently results in a vast development of phytoplankton, in some waters where macrophytes are abundant, eutrophication may not result in blooms for a long time. Prevention of eutrophication can be accomplished by reduction of nutrient input in industrial and municipal wastes. Preliminary work has been done on the recovery of biomass from eutrophic waters and its utilization for fertilizer or as a raw material. (Moore-IVI)
W84-01676

ACID PRECIPITATION: WHAT IS IT DOING TO OUR FORESTS,
Environmental Law Inst., Washington, DC.
G. S. Wetstone, and S. A. Foster.
Environment, Vol. 25, No. 4, p 10-12 and 38-40, May, 1983. 2 Fig, 35 Ref.

Descriptors: *Acid rain, *Forests, Rainfall, Air pollution, Sulfur dioxide, Sulfates, Acidity, Soil properties, Soil chemistry.

Evidence is growing of serious problems in forests of the Central European region and eastern North America. In West Germany, fully 560,000 hectares of forests have recently been damaged. Trees have died in 60,000 ha of the nation's forests, and those in another 100,000 ha are reported to be seriously damaged. In Eastern Europe sulfur dioxide emission levels are extremely high. More than 500,000 ha of forests in Czechoslovakia have been severely damaged. Only recently has acid deposition emerged as a potentially sweeping threat to forests, especially in Central Europe. Some of the devastation is brought about as a consequence of contact between acid waters and the plant tissues. Rainfall in the pH range of 3.0 to 4.0 has been shown to cause tissue injury which can ultimately reduce forest growth. However, rainfall at such a low pH level is not common. Preliminary evidence suggests that indirect effects resulting from acid-induced soil changes are far more important. Acid deposition upsets the natural balance in the soils. Negatively charged sulfate ions, after accumulating in soils, can be washed out by rains, carrying with them nutrients such as calcium and magnesium. Acid conditions also slow the bacterial decompositon needed for the continued production of nutrients. In the long term pollution induced nutrient depletion accelerates the natural forest aging process, leading to the eventual exhaustion of the soil's ability to sustain tree growth. Acid-induced forest impacts are probably magnified in some instances by the increases in rainwater acidity as it passes through the forest canopy and runs down the tree bark, adsorbing in the journey dry-deposited acids present on the surfaces of plants. It is not certain at present whether acid-afflicted forests can be saved or whether acid induced impacts on forests or forest soils reversed. (Baker-IVI)
W84-01700

5D. Waste Treatment Processes

NEW WASTEWATER PROCESS CUTS PLANT COSTS 60%,
Burns and McDonnell, Kansas City, MO.
S. Christopher, and R. Titus.
Civil Engineering, Vol. 53, No. 5, p 39-41, May, 1983. 3 Fig.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, System design, Clarifiers, Sludge digestion, Costs, Municipal wastewater.

A new concept in biological treatment for municipal wastewater combines the aerator and the clarifier into one basin and can thereby slash capital costs up to 60% and operation and maintenance costs up to 45%. Raw sewage enters the treatment system at the aeration basin, is aerated, then passes beneath an innovative intrachannel clarifier. A portion of the mixture of wastewater and activated sludge, commonly called mixed liquor, rises into the clarifier through openings in the clarifier bottom panels. Solids are separated, fall down through the openings and return to the continuously flowing mixture below. Effluent is removed in the upper portion of the clarifier through orifice pipes submerged about one foot beneath the water's surface. As there are no sludge blankets, the full depth of the clarifier is available for maximum settling. Solids settling downward from the quiescent zone also act as a filter to remove materials in the liquor that are flowing up into the quiescent zone. Under varying operating conditions sustained overflow rates ranged from 600 to 2,100 gallons per day per square foot and the BODs and suspended solids effluent requirements were still met. Effluent quality is not significantly degraded when running at very high flow rates due in part to the capability of the clarifer to distribute flow evenly across the entire surface area and to the capability of the submerged orifice effluent system to dampen peak flows. (Baker-IVI)
W84-01481

CHEMICAL CHANGES IN CONCENTRATED, ACIDIC, METAL-BEARING WASTEWATERS WHEN TREATED WITH LIME,
Montana State Univ., Bozeman. Dept. of Chemistry.
D. R. Jenke, G. K. Pagenkopf, and F. E. Diebold.
Environmental Science and Technology, Vol. 17, No. 4, p 217-223, April, 1983. 4 Fig, 5 Tab, 38 Ref. 0264022.

Descriptors: *Lime, *Neutralization, *Acid mine drainage, *Industrial wastewaters, Precipitation, Computers, Simulation, Adsorption, Wastewater treatment, Iron, Magnesium, Manganese, Zinc, Metals.

Appropriate disposal of acid-bearing waters resulting from base-metal industrial works and coal mine drainage continues to be a major problem. Because of economic considerations, lime neutralization with subsequent precipitation is one of the most popular techniques for treatment of these wastewaters. Lime neutralization of acidic wastewaters can prove to be an effective treatment process provided sufficient lime is added. The chemical changes that occur in the system are extensive and varied. Precipitation is predominant with complexation, oxidation, and adsorption playing major roles. Total chemical analyses have identified the chemical changes, and controlled laboratory simulations have identified the relative importance of the physical-chemical processes. The transfer of O2 and CO2 from the atmosphere does not play a major role in the chemistry of transferring the metals from solution to the solid phase. The time interval is too short and the gas-liquid interface area is too small to permit sufficient quantities of these two reagents to enter the system. Adsorption-coprecipitation is indicated as the process that greatly facilitates the removal of Fe(2+), Mg(2+), Mn(2+), and possibly Zn(2+) from solution. Optimum lime addition rates are predicted by thermodynamic computer simulation. (Moore-IVI)
W84-01496

WASTEWATER TREATMENT PLANT, PROCESS CONTROL EXPERIENCES USING A MINICOMPUTER,
Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
B. A. Monaghan.
Canadian Journal of Civil Engineering, Vol. 10, No. 2, p 214-222, June, 1983. 9 Fig, 1 Tab, 13 Ref.

Descriptors: *Activated sludge process, *Computers, *Wastewater treatment, *Data acquisition, Automation, Process control, Monitoring, Pilot plants.

Since 1978, the Wastewater Technology Centre has investigated the use of continuous monitoring sensors and real-time computers for automated data acquisition and control of the activated sludge process. The aim of this work is to improve plant performance and reliability through the application of effective process control strategies. This paper highlights experiences pertaining to: (a) evaluation of online instrumentation: (b) software development for data acquisition and control; and (c) process control strategies investigated. The majority of this study was carried out using two parallel 16.4 cu m/d pilot plants interfaced to an HP 100 minicomputer.
W84-01512

PARTICLE SIZE REDUCTION BY BREAKAGE IN BIOLOGICAL WASTEWATER TREATMENT,
Kansas State Univ., Manhattan. Dept. of Chemical Engineering.
L. A. Glasgow, R. J. Pollock, and W. A. Barkley.
Biotechnology and Bioengineering, Vol. 25, No. 4, p 901-918, April, 1983. 9 Fig, 3 Tab, 21 Ref.

Descriptors: *Biological wastewater treatment, *Floc breakup, *Hydrodynamics, Eddies, Vortices, Flocculation, Particle size, Aeration, Recirculation, Mixing, Jets.

Floc breakup in biological wastewater treatment occurs in response to hydrodynamic stresses imposed by aeration, recirculation, and mixing. This size reduction is of particular concern because it leads to solids carry-over and adversely affects process controllability. A laboratory study of floc size reduction has shown how the hydrodynamic environment causes breakup and the extent to which it proceeds at particular levels of dissipation. Vortex structures and hairpin eddies are among the most dangerous fluid motions from the standpoint of floc integrity. The combination of deformation and rotation can lead to thorough breakage, which appears to be initiated by stripping of subunits from the floc surface; the initial daughter particles or fragments, however, are far larger than typical primary colloidal particles. The structure of jet flows was found to be well-suited for the reduction of floc size. (Moore-IVI)
W84-01514

SOME FLUIDIZATION CHARACTERISTICS OF BIOLOGICAL BEDS,
Toronto Univ. (Ontario). Dept. of Civil Engineering.
S. W. Hermanowicz, and J. J. Ganczarczyk.
Biotechnology and Bioengineering, Vol. 25, No. 5, p 1321-1330, May, 1983. 2 Fig, 2 Tab, 14 Ref.

Descriptors: *Fluidized beds, *Wastewater treatment, Particles, Drag, Biofilms, Porosity, Zaki-Richardson method.

Biological fluidized bed technology has been applied to different processes of wastewater purification. In these applications, the hydraulic characteristics of the bed may sometimes decide the success or failure of a particular installation. The free-fall terminal velocity of particles coated with a nitrifying biofilm was investigated. The drag force exerted by the liquid on a biocoated particle was found larger than that for an uncoated particle. A new formula for the drag coefficient was proposed. The wet density of biofilm was estimated as 1.14 g/cu cm. A proposed modification of the Zaki-Richardson method was successfully used for calculations of the porosity of a fluidized bed. (Moore-IVI)
W84-01515

DEPENDENCE OF BIOLOGICAL TREATMENT RATE ON SPECIES COMPOSITION IN ACTIVATED SLUDGE OR BIOFILM. I: A BIOLOGICAL TREATMENT MODEL WITH ECOSYSTEM ADAPTATION,
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
V. A. Vavilin, and V. B. Vasiliev.
Biotechnology and Bioengineering, Vol. 25, No. 6, p 1521-1538, June, 1983. 2 Fig, 6 Tab, 7 Ref.

Descriptors: *Biological wastewater treatment, *Species composition, Mathematical models, Ecosystem adaptation, Microorganisms, Organic loading.

A biological treatment model with ecosystem adaptation (ESA model) is proposed as a means of describing multicomponent sewage treatment. The distribution of microorganisms which oxidize different components of the pollutant is strongly dependent on organic loading. The model can be used to compute multistep treatment systems with specific microflora at each step. (Author's abstract)
W84-01516

DEPENDENCE OF BIOLOGICAL TREATMENT RATE ON SPECIES COMPOSITION IN ACTIVATED SLUDGE OR BIOFILM. II: FROM MODELS TO THEORY,
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
V. A. Vavilin.
Biotechnology and Bioengineering, Vol. 25, No. 6, p 1539-1570, June, 1983. 18 Fig, 1 Tab, 54 Ref.

Descriptors: *Biological wastewater treatment, *Mathematical models, Microorganisms, Pollutants, Ecosystem adaptation.

Traditional biological treatment models are deduced from formal chemical kinetics or dynamics of pure microorganisms cultures growth. The penalty for their simplicity is an essentially limited usefulness. Transition to models which take into account the heterogenous nature of the biomass and pollutant allows one to solve more intricate problems and contributes to a better understanding of the biological treatment process. The best models give reasonable approximations of the biological treatment model with an ecosystem adaptation (ESA model). The model presented here explains some features of the biological treatment mechanism that cannot be described by formal models. (Moore-IVI)
W84-01517

ENTEROVIRUS REMOVAL BY A FULL-SCALE TERTIARY TREATMENT PLANT,
Montgomery (James M.), Inc., Pasadena, CA.
L. Y. C. Leong, D. G. Argo, and R. R. Trussell.
Journal of the American Water Works Association, Vol. 75, No. 4, p 199-204, April, 1983. 4 Fig, 11 Tab, 9 Ref.

Descriptors: *Enteroviruses, *Advanced wastewater treatment, Disinfection, Chlorination, Effluent, Dilution, Injection.

A four-year study in which enteroviruses were monitored at a 56-ML/d (15-mgd) advanced wastewater treatment plant is summarized. The process train included high pH-lime treatment, air stripping, recarbonation, prechlorination, multimedia filtration, granular activated carbon adsorption, reverse osmosis demineralization, and final chlorination. The influent and effluent were sampled on the average of once per week. During this study, viruses were detected twice in chlorinated effluent at very low levels and were associated with operational problems of the final disinfection process. Subsequent dilution by blending and injection of the final effluent into a groundwater aquifer, which resulted in additional dilution and treatment, has produced a water that is essentially free of enteroviruses. (Author's abstract)
W84-01525

OVERVIEW OF RURAL WATER AND SANITATION PROGRAMS FOR LATIN AMERICA,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
For primary bibliographic entry see Field 5F.
W84-01528

FERRIC CHLORIDE AND ALUM AS SINGLE AND DUAL COAGULANTS,
Air Force Hospital, Wurtsmith AFB, MI.
For primary bibliographic entry see Field 5F.
W84-01529

ODOUR CONTROL IN SOLID WASTE MANAGEMENT,
Imperial Coll. of Science and Technology, London (England). Public Health Engineering Lab.
J. M. Baker, C. J. Peters, R. Perry, and C. P. V. Knight.
Effluent and Water Treatment Journal, Vol. 23, No. 4, p 133-138, April, 1983. 2 Fig, 2 Tab, 36 Ref.

Descriptors: *Odor control, *Solid wastes, Wastewater treatment, Sulfur, Nitrogen, Oxidation, Cost analysis, Anaerobic conditions, Hydrocarbons, Fatty acids.

The decision to implement odor abatement measures in the management of solid wastes disposal will generally arise as a result of odor nuisance complaints. Odor emissions arise from the disturbance of organic material undergoing anaerobic fermentation and are generally caused by the presence of sulfur and nitrogen containing compounds, fatty acids, esters and naturally occurring hydrocarbons. Odor control may be best carried out by efforts to keep the material aerobic, to avoid disturbance of anaerobic material and to provide coverings which prevent gaseous emission; by camouflaging the smell to make it acceptable; and by oxidation of the malodorants to the odorless end products of carbon dioxide and water. If a method of oxidation is chosen, then financial, energy and space requirements, in addition to volume and concentration of odor and efficiency of odor reduction required will dictate the method to be used. There is evidently a need for further study in the chemical nature of odorants associated with solid waste degradation. While sensory methods for assessing the level of oxidant odorants are now well stabilized, the results they give are necessarily subjective. Instrumental analytical techniques must be developed to chemically identify the major constituents of the odor and hence enable a suitable method of abatement or eradication to be used. (Baker-IVI)
W84-01564

RECLAMATION OF WASTEWATER CONSTITUENTS BY ION EXCHANGE, PART I. REVIEW OF FLOWSHEETS FOR THE PROCESSES - CONTINUED FROM VOLUME 23 NUMBERS 1 AND 2,
B. A. Bolto, and L. Pawlowski.
Effluent and Water Treatment Journal, Vol. 23, No. 4, p 159-167, April, 1983. 6 Fig, 3 Tab, 56 Ref.

Descriptors: *Reclaimed water, *Ion exchange, *Metal finishing wastes, Nickel, Copper, Mercury, Heavy metals, Zinc, Molybdenum, Selenium, Arsenic, Resins.

The typical ion exchange system for recycling the constituents of rinse water coming from chromic and cyanide operations of metal finishing plants consists of a cation exchanger unit followed by an anion exchange unit. The recovery of metals is possible when the streams of rinse water to be treated are separated, allowing the regeneration effluents to be appropriately mixed. Another method of treatment is to separate some of the heavy metals from the mixture. With conventional resins it is possible to obtain selective removal of heavy metals from effluents. Specific resins for the selective removal of ions are also known. The biggest environmental problem associated with nickel arises from metal finishing plants where its recovery is possible only if the nickel-bearing effluent is separated from other effluents. There are several copper baths which contain sulfate or chloride, and the general concept of their treatment is as for the treatment of nickel bearing effluents. Another application of ion exchange for the recovery of copper is the treatment of effluents from leaching operations in copper production. For removal of zinc, the zinc cation may be taken up by a cation exchanger or a chelate resin, and the anion by an anion exchanger. Most of the mercury resulting from industrial waste comes from chlorine and caustic manufacturing plants. Re-use of mercury from the wastewater treatment can reduce the cost of treatment by about 25%. Recovery of precious metals and rare elements is also possible. (Baker-IVI)
W84-01568

FLOCCULATION TEST METHODS,
University Coll., London (England). Dept. of Civil Engineering.
J. Gregory.
Effluent and Water Treatment Journal, Vol. 23, No. 5, p 199-205, May, 1983. 3 Fig, 35 Ref.

Descriptors: *Flocculation, *Testing procedures, Zeta potential, Colloids, Sedimentation, Permeability, Electrophoresis, Jar testing, Chemical coagulation, Water treatment, Wastewater treatment.

The essential steps in the flocculation of a water containing suspended particles are destabilization of the particles by eliminating any repulsion between them, and collisions of destabilized particles to form aggregates, or flocs. Proper operation of a flocculation process requires that the correct dosages of reagents be used, with efficient mixing, and that the destabilized particles are provided with sufficient contact opportunity to form aggregates of the required size and properties. The flocculation test procedure establishes the optimum chemical conditions for floc formation. Ideally the test procedure should simulate the operation of a full-scale unit and be capable of predicting plant performance on the basis of laboratory trials. Measurement of the particle charge as a function of reagent dose can give a good indication of the optimum dosage. The most common approach is to measure the zeta potential of the particles. Another technique which can give similar information without the use of elaborate equipment is colloid titration. This test depends on the fact that water-soluble polyelectrolytes of opposite charge to the suspension particles will adsorb strongly until the particle charge is neutralized. Properties of flocculated suspensions which should be determined include sedimentation and permeability. The jar test procedure can be used to determine many of the properties of the flocculated suspensions. However, such testing has disadvantages, including time consumed to complete the test procedure. Alternatives to the jar test are being developed with two different aims: to provide a test method which is more rapid and convenient giving information on optimum chemical conditions; and to give result which are more closely related to flocculation performance in actual flocculation plants. (Baker-IVI)
W84-01570

A COMPARISON OF AN INDUSTRIAL AND DOMESTIC SEWAGE,
T. Stones.
Effluent and Water Treatment Journal, Vol. 23, No. 5, p 206-207, May, 1983. 4 Tab, 9 Ref.

Descriptors: *Wastewater treatment, *Design criteria, Effluents, Industrial wastes, Domestic wastes, Biochemical oxygen demand, Oxygen demand.

The relative strengths of industrial vs domestic sewages have been expressed in terms of various criteria. The anomalies in results are due to differences in the extent of oxidation of the two sewages under the conditions of the various determinations. During the determination of the chemical oxygen demand there is virtually complete oxidation of the carbonaceous matter so that this gives an absolute value for the total carbonaceous oxygen demand and hence provides a basis with which the other criteria can be compared. The 5-days biochemical oxygen demand thus represents 54.2% of the total carbonaceous oxygen demand in the case of the domestic sewage but only 37.2% thereof in the case of the industrial sewage which is relatively 31.4% less, while the permanganate value represents 10.1% of the total carbonaceous oxygen demand in the case of the domestic sewage but 13% thereof in the case of the industrial sewage which is relatively 28.7% more. A substantial amount of the carbonaceous matter present in sewage that is inert to biochemical oxidation under the normal conditions is removed during the course of treatment and so constitutes a significant part of the oxidizable load imposed upon a biological oxidation plant. The use of the 5-day BOD as a basis for determining the capacities of such plants is therefore illogical as it leads to the paradoxical situation in which plants of smaller capacity are thereby calculated as being necessary for the treatment of intractable industrial sewages than for those intended to deal with equal volumes of domestic sewages readily amenable to treatment. (Baker-IVI)
W84-01571

RECLAMATION OF WASTEWATER CONSTITUENTS BY ION EXCHANGE; PART I REVIEW OF FLOWSHEETS FOR THE PROCESSES - CONTINUED FROM VOLUME 23 NUMBERS 1, 2 AND 4,
B. A. Bolto, and L. Pawlowski.
Effluent and Water Treatment Journal, Vol. 23, No. 5, p 208-213, May, 1983. 6 Fig, 24 Ref.

Descriptors: *Recycling, *Ion exchange, *Wastewater renovation, Municipal wastes, Dye industry, Industrial wastes, Agricultural wastes, Waste recovery, Regeneration, Minerals, Phosphates, Nitrates, Water reuse.

The concentration of solutions by evaporation produces condensates which may contain several to a few thousand milligrams of solute per liter. An ion exchange method can be used for recycling the chemicals and the water from the condensate. One of the best known examples is the recycling of condensate constituents from the fertilizer industry. The most important factor affecting the economics of ion-exchange methods is the concentration of the regeneration effluent; special columns are used to increase its concentration. The main problem in the system is to ensure uniform flow of the regeneration effluent through the ion-exchange bed. If regeneration effluents containing (NH4)2SO4 are introduced into the processing of ammonium nitrate, the durability of the ammonium nitrate granules is increased which improves their quality as a fertilizer. The removal of nutrients from wastewaters becomes a very important goal to ensure survival of water supplies. An interesting attempt to use ion exchange for the recovery of ammonium and phosphate ion is based on the selective adsorption of ammonium ions on clinoptilolite and of phosphate on an anion exchanger, and on the precipitation of MgNH4PO4 from the regeneration effluent. Another approach uses nitric acid and ammonia to regenerate an ion exchanger bed for the tertiary treatment of effluents. The regeneration effluent, being a mixture of ammonium and nitrate salts, is used as a fertilizer. Ion exchange methods have recently been used in recovering organic compounds from wastes such as the separation of sulfonic and sulfuric acids. In the dyeing of acrylic fibers with cationic dyes, the used dye bath and wash liquors are recycled through a three-column system: activated charcoal followed by two cation exchanger beds in the H-form. Recovered water is recycled. Recovery of water from brackish agricultural and municipal wastewater has also been proposed. The regeneration effluent from ion exchange softening plants can also be reused. (Baker-IVI)
W84-01572

A REVIEW OF ACTIVATED SLUDGE TREATMENT; PART I,
M. S. Ray.
Effluent and Water Treatment Journal, Vol. 23, No. 6, p 225, 227-229 and 231-232, June, 1983. 3 Fig, 5 Tab.

Descriptors: *Activated sludge process, *Wastewater treatment, Oxygen, Oxidation, Unox process, Cost analysis, Bacteria, Aeration tanks, Nitrification, Microorganisms.

A concise summary of the nature of the activated sludge treatment process is presented along with a discussion of the use of pure oxygen for treatment, a description of the Unox process with useful data and associated costs, and the mention of oxygenation systems other than tank-based processes. A wide variety of microorganisms are found in activated sludge including bacteria, filamentous growths, algae and protozoa. There is a favorable range of pH over which bacterial activity is at a maximum, and deviations result in a reduction of efficiency. An aeration system is generally used to dissolve oxygen in the liquid, strip out carbon dioxide, mix aerated liquid and bacterial sludge, and maintain solid matter in suspension. Two major types of systems include the diffused air system and the mechanical aeration system. Potential advantages of the use of oxygen in place of air for activated sludge treatment have been studied. Potential advantages include efficient oxygen dissolution and increased biomass concentration. Potential disadvantages of an oxygen system include the effect of high dissolved oxygen levels, sludge settling rates, excess sludge generation, higher MLSS levels, nitrification, shock loads, bulking, sludge thickening, power consumption, and capital cost. (Baker-IVI)
W84-01573

RECLAMATION OF WASTEWATER CONSTITUENTS BY ION EXCHANGE; PART II REVIEW OF CONTACTING EQUIPMENT,
B. A. Bolto, and L. Pawlowski.
Effluent and Water Treatment Journal, Vlo. 23, No. 6, p 233-239, June, 1983. 13 Fig, 25 Ref.

Descriptors: *Recycling, *Waste recovery, *Water reuse, *Ion exchange, Regeneration, Wastewater treatment.

The application of ion-exchange reclamation systems to recycling is considered. Application has historically been divided into moving-bed systems and fixed-bed systems. The moving bed systems may be further divided into cocurrent and countercurrent systems. Countercurrent moving bed systems may be divided into semicontinuous and truly-continuous systems which make use of a compact or fluidized bed. Fixed bed systems may be divided into cocurrent and countercurrent versions, in compact or fluidized bed formats. Another feature which distinguishes the various contacting methods is the sequence and direction of flows through the various process units during loading and regeneration. Use of a moving bed allows one to perform continuous ion-exchange operations which are attractive because of their processing efficiency and their similarity to continuous solvent extraction or distillation. While the fixed bed systems perform reliably in many types of effluent treatments, in the treatment of wastewater one very often has to deal with high turbidity solutions and liquids having a high concentration of solutes. In such cases continuous countercurrent fluidized systems can provide more efficient performance. When the effluent to be treated has a high level of turbidity the CSIRO concept of a continuous apparatus based on magnetic resins can be very useful. The proper selection of contacting equipment for carrying out ion exchange processes in effluent treatment is critical. (Baker-IVI)
W84-01574

TREATMENT OF OLIVE OIL WASTES BY DISTILLATION,
M. C. Annesini, A. R. Giona, F. Gironi, and F. Pochetti.
Effluent and Water Treatment Journal, Vol. 23, No. 6, p 245-248, June, 1983. 2 Fig, 5 Tab, 13 Ref.

Descriptors: *Wastewater treatment, *Distillation, *Olive oil, Industrial wastes, Food-processing wastes.

A method is proposed for the physico-chemical characterization of the wastewater effluent from olive oil mills by means of batch distillation runs. The experimental results allow individual equilibrium ratios and initial concentrates of three pseudocompounds which can be used to describe the behavior of vegetable waters in an industrial distillation process. The method can be applied to other industrial effluents with characteristics similar to those of vegetable waters. In the production of oil there are two consecutive centrifugations, in the first of which the cake is separated from the liquid phase while in the second the oil is separated from the water. The vegetable waters are useless residues with strong pollution potential. Treatment of such waters is conditioned by its characteristics: the high organic loading expressed in terms of COD or BOD, the discontinuity caused by the seasonal processing of olives, and the low flow rate due to the small capacity of the oil mills. Commonly used processes to deal with the problem include aerobic biological processes, chemical processes based on the precipitation of pollutants, and physical processes. The physicochemical characterization of the effluent is considered. On the basis of the findings of a study of batch distillation, a rough evaluation of the distribution of pollutant compounds between the liquid and the vapor phase is possible. A distillation treatment process is suggested. Experimental runs were carried out. The values of the equilibrium ratio of three pseudocompounds and their temperature dependence have been determined. (Baker-IVI)
W84-01576

INGESTION AND ASSIMILATION RATES OF OOCYSTIS SP. BY DAPHNIA MAGNA IN TREATED WASTEWATERS,
Laval Univ., Quebec. Dept. de Biologie.
B. Myrand, and J. de la Noue.
Environmental Pollution, (Series A) Vol. 31, No. 3, p 77-95, June, 1983. 6 Fig, 1 Tab, 48 Ref.

Descriptors: *Biological wastewater treatment, *Daphnia, *Oocystis, Nutrient removal, Food, Phytoplankton.

Although the effluent from the sewage treatment plant is an improvement over untreated effluent, this discharge is still rich in nutrients which accelerate the eutrophication of the collector stream. It has been proposed that the fertilizer potential of these wastewaters could be used to produce food through the controlled growth of phytoplankton. This study was aimed at examining the possibility of using Daphnia magna to recover the phytoplankton produced in high concentration during the biological treatment of wastewaters. Ingestion rate, assimilation rate and assimilation efficiency were measured for Daphnia grown under controlled experimental conditions in secondary treated wastewaters. The rate of ingestion was higher at 15 C than at 20 C and depended on the concentration of algae (Oocystis sp.) used: 10 and 50 mg C/l. The rate of assimilation was constant at about 1-8 micro g C per Daphnia per hour. It is proposed that the incipient limiting level of ingestion corresponds to the concentration where the assimilation rate is maximum. At food concentrations higher than this level of ingestion, Daphnia control mechanisms normally maintain a constant ingestion rate and prevent superfluous feeding. These results, however, revealed the inefficiency of these mechanisms at high food concentrations, leading Daphnia to superfluous feeding. Nevertheless, Daphnia re-

veals itself as a good candidate for the filtration of Oocystis produced in wastewaters. (Moore-IVI)
W84-01590

ALTERNATIVE POLICY INSTRUMENTS UNDER UNCERTAINTY: A PROGRAMMING MODEL OF TOXIC POLLUTION CONTROL,
Meta Systems, Inc., Cambridge, MA.
P. J. Morgan.
Journal of Environmental Economics and Management, Vol. 10, No. 3, p 248-269, September, 1983. 10 Fig, 28 Ref.

Descriptors: *Wastewater treatment, *Industrial wastwater, *Regulation, Water pollution control, Metal-finishing wastes, Mathematical models, Pricing, Economic aspects, Bridgeport, Connecticut.

A programming model was developed which examines the relative performance of different regulatory regimes under uncertainty in controlling toxic wastes discharged by industry to a central treatment plant when the central plant is subject to threshold-type losses in treatment performance. Four regulatory regimes are examined: non-market quantity, price, marketable permit, and mixed price-quantity. The theoretical framework of the model is based on the analysis of prices vs quantities by Weitzman in 1974 and its extension to the case of a discontinuous threshold effect. The data used are based on the situation of Bridgeport, Connecticut, which has a number of metal finishing firms. The strong points of the model include a specification of uncertainty based on econometric results, an ability to model a variety of sophisticated regulatory environments, a materials-balance approach which accounts for all liquid and solid residues, specification of recycling and flow reduction as well as end-of-pipe treatment capabilities for firms, and explicit use of environmental impact functions rather than quantity standards. All three market regimes perform much better than the non-market quantity regime if discharge benefits are uncorrelated across firms. (Moore-IVI)
W84-01609

LONGEVITY OF SALMONELLA TYPHIMURIUM IN TILAPIA AUREA AND WATER FROM POOLS FERTILIZED WITH SWINE WASTE,
Auburn Univ., AL. Dept. of Fisheries and Allied Aquacultures.
For primary bibliographic entry see Field 5B.
W84-01655

SAMPLING STRATEGY FOR DETECTING VIRUSES IN A SEWAGE TREATMENT PLANT,
Nancy-1 Univ. (France). Lab. d'Hygiene et de Recherche de la Sante Publique.
D. Rolland, J. C. Joret, F. Villeval, J. C. Block, and P. Hartemann.
Applied and Environmental Microbiology, Vol. 45 No. 6, p 1767-12774, June, 1983. 3 Fig, 10 Tab, 20 Ref.

Descriptors: *Wastewater treatment, *Viruses, *Sampling, Activated sludge process, Enteroviruses, Coliforms, Chemical oxygen demand, Biochemical oxygen demand, Suspended solids, Raw wastewater, Biological wastewater treatment, Hourly variation, Nancy, France.

A study of pollutant flows was carried out at a wastewater treatment plant in Nancy, France, which used activated-sludge treatment. The plant receives 150,000 cu m of sewage daily from a 300,000-inhabitant community. A comparison between two methods of sampling was conducted: dip samples every 2 h over a period of 24 h and one 24-h composite sample were taken from raw and treated wastewater and then analyzed for enteroviruses, fecal coliforms, chemical oxygen demand, biochemical oxygen demand, and suspended solids. The results showed that the hourly variations of these pollutants in the effluents are in good agreement with expectations based upon the customers' usage and the characteristics of the wastewater network. Significant correlations were found between all tested parameters and enteroviruses in raw wastewater. After biological treatment, no correlation remained in treated wastewater between viruses and other parameters. As for the two sampling methods, a rather good representation of the daily load was given by the composite mode of sampling as concerns physicochemical and microbiological parameters. Biological treatment removed an average of 83% of viruses. A minimum of 300,000,000 PFU of enteric viruses are discharged daily from this plant. (Moore-IVI)
W84-01659

ELECTRON MICROSCOPIC EXAMINATION OF WASTEWATER BIOFILM FORMATION AND STRUCTURAL COMPONENTS,
New Hampshire Univ., Durham. Dept. of Civil Engineering.
T. T. Eighmy, D. Maratea, and P. L. Bishop.
Applied and Environmental Microbiology, Vol. 45, No. 6, p 1921-1931, June, 1983. 7 Fig, 52 Ref.

Descriptors: *Biofilms, *Wastewater, *Bacteria, Glycocalyx, Matrix, Electron microscopy.

A biofilm is an assemblage of bacterial cells that is both enclosed by and attached to a wetted surface by means of an extracellular fibrous polysaccharide-containing matrix, termed a glycocalyx. In situ wastewater biofilm formation, structure, and physicochemical properties were studied by scanning and transmission electron microscopy. Cationized ferritin was used to label anionic sites of the biofilm glycocalyx for viewing in thin section. Wastewater biofilm formation paralleled the processes involved in marine biofilm formation. Scanning electron microscopy revealed a dramatic increase in cell colonization and growth over a 144-h period. Constituents included a variety of actively dividing morphological types. Many of the colonizing bacteria were flagellated. Filaments were seen after primary colonization of the surface. Transmission electron microscopy revealed a dominant gram-negative cell wall structure in the biofilm constituents. At least three types of glycocalyces were observed. The predominant glycocalyx possessed interstices and was densely labeled with cationized ferritin. Two of the glycocalyces appeared to mediate biofilm adhesion to the substratum. The results suggest that the predominant glycocalyx of this thin wastewater biofilm serves, in part, to enclose the bacteria in a matrix and anchor the biofilm to the substratum and provide an extensive surface area with polyanionic properties. (Moore-IVI)
W84-01661

IMPROVED EVAPORATORS FOR RADIOACTIVE WASTES,
Graver Co., Union, NJ. Unitech Div.
D. Anthony.
Chemical Engineering Progress, Vol. 79, No. 7, p 58-63, July, 1983. 3 Fig, 5 Tab, 5 Ref.

Descriptors: *Wastewater treatment, *Radioactive wastes, *Ammonia, *Corrosion, Water reuse, Reclaimed water, Industrial wastes.

Evaporation can be an effective and economical means of treating radioactive waste in the nuclear plant. It reduces the waste volume through evaporation of the volatile solvent (water) resulting in a smaller volume and smaller mass of contaminated material for ultimate storage or disposal. Relatively pure water (condensed vapor), is recovered and can be recycled or reused within the plant or discharge to the environment with little or no additional treatment. One of the largest contributing sources of radwaste in a nuclear plant is the waste effluent produced in the regeneration of ion exchange resins. This waste typically consists of a solution of roughly 1-2% sodium sulfate in water. Difficulties in operating radwaste evaporators have stemmed mainly from corrosion, but new materials are being made which are more corrosion resistant. The chemical regeneration of demineralizer beds is accomplished by passing appropriate chemical solutions through the resin beds. The presence of significant amounts of ammonia and ammonia compounds in evaporator or crystallizer feed streams has recently been found to cause some potentially serious difficulties which can be classified into three categories: distillate quality, solidification considerations, and corrosion problems. To avoid these problems it is necessary to remove the ammonia from the feed before it enters the evaporator. This can be accomplished by raising the feed pH by the addition of NaOh to the feed tank, and processing the feed through a stripping column which removes the volatile ammonia by steam stripping. The system is effective in reducing the feed ammonia concentration by at least a factor of 200. (Baker-IVI)
W84-01665

TRANSFERABLE DISCHARGE PERMIT TRADING UNDER VARYING STREAM CONDITIONS: A SIMULATION OF MULTIPERIOD PERMIT MARKET PERFORMANCE ON THE FOX RIVER, WISCONSIN,
Colby Coll., Waterville, ME. Dept. of Economics.
For primary bibliographic entry see Field 6E.
W84-01702

ACTIVATED SLUDGE TREATMENT OF SYNTHETIC WASTEWATER CONTAINING PENTACHLOROPHENOL,
Cornell Univ., Ithaca, NY. School of Chemical Engineering.
R. U. Edgehill, and R. K. Finn.
Biotechnology and Bioengineering, Vol. 25, No. 9, p 2165-2176, September, 1983. 4 Fig, 2 Tab, 19 Ref.

Descriptors: *Activated sludge process, *Pentachlorophenol, *Wastewater treatment, Industrial wastes, Wood treatment wastes, Pesticides, Wood preservatives, Arthrobacter, Phenols, Shock load.

Treatment of wood products with preservative formulations containing pentachlorophenol (PCP) often results in the generation of polluted effluents, and conventional activated sludge treatment of wastewaters containing PCP is inefficient and unreliable. With a synthetic waste containing some sugars, and 40-120 mg/l PCP, laboratory activated sludge required about seven days for acclimation. The prior addition of a quasipure culture of PCP-metabolizing Arthrobacter resulted in immediate acclimation. Even with acclimated sludge, the system was upset for two days by a simple step change from 40 to 120 mg/l of PCP. The stability of the system to such a shock load was considerably improved when a chemostat culture of the PCP-metabolizing Arthrobacter was fed slowly into the mixed liquor. Kinetic models were developed to describe the dynamic response of the system in terms of growth parameters, hydraulic detention time, sludge age, and bleed-in rate from the chemostat. (Moore-IVI)
W84-01757

FACTORS REGULATING THE DENSITY OF BACTERIA IN PROCESS WATERS OF A PAPER MILL,
Helsinki Univ. (Finland). Dept. of Microbiology.
P. Vaatanen, and S. I. Niemela.
Journal of Applied Bacteriology, Vol. 54, No. 3, p 367-371, June, 1983. 4 Tab, 8 Ref.

Descriptors: *Pulp and paper industry, *Process water, *Bacteria, Klebsiella, Acinetobacter, Pseudomonas, Water temperature, Hydrogen ion concentration, Redox potential, Finland.

Variations in the numbers of total colonies of Klebsiella pneumoniae, Acinetobacter spp. and pseudomonads were investigated in process waters of a paper mill in southern Finland. Variations were related to independent parameters, namely temperature, pH, redox potential and production of offset paper, by using multiple regression analysis. Temperature was the most significant regressor variable and was negatively correlated with bacterial counts. It accounted for up to about 80% of the variance in bacterial counts in various parts of the process. The significance of temperature was due to its fluctuations in a critical range, above and below the maxima for bacterial growth. The pH level was also significant for total colony count and for K. pneumoniae. Redox potential and the production of offset paper were of significance for

Acinetobacter spp. Washing the paper machine with water and lye decreased the numbers of bacteria in process waters. (Author's abstract)
W84-01766

5E. Ultimate Disposal Of Wastes

LAND TREATMENT OF HAZARDOUS WASTE,
A. Morrison.
Civil Engineering, Vol. 53, No. 5, p 33-38, May, 1983. 1 Fig, 3 Tab.

Descriptors: *Waste disposal, *Land disposal, *Organic compounds, Oils, Pesticides, Solvents, Inorganics, Hazardous materials, Waste management, Monitoring.

Land treatment, or land cultivation, is both controversial and promising. The controversy stems from the poor state of knowledge about the fate and transport of chemicals, especially hazardous ones, in the soil. In land treatment selected wastes are applied to a topsoil layer where they are broken down organically or immobilized. At some sites wastes were flood-irrigated onto the soil then allowed to dry. There are roughly 200 land treatment sites in operation, over 100 of them at refineries and almost all of them used by industrial concerns needing to dispose of their own wastes. Testing must be done to determine the suitability of the wastes before instituting operation of the system. Monitoring systems must be designed to determine the condition of the groundwater and the soil in the unsaturated zone beneath the treatment zone. In order for this management intensive process to function it is important to determine what types of wastes and what amounts are able to be so treated. Organics are probably better candidates for land treatment than inorganics. Particularly suitable are solvents, pesticides, and oils. System failure may result if wastes containing highly resistant or mobile compounds are applied as they may leach to the groundwater through a permeable soil layer. The most important of the EPA land regulations is that a demonstration pior to facility start up must be performed. (Baker-IVI)
W84-01480

MUTAGENICITY OF MUNICIPAL SEWAGE SLUDGES OF AMERICAN CITIES,
New York State Coll. of Veterinary Medicine, Ithaca. Dept. of Preventive Medicine.
J. G. Babish, B. E. Johnson, and D. J. Lisk.
Environmental Science Technology, Vol. 17, No. 5, p 272-277, May, 1983. 2 Tab, 26 Ref. 507 RR05462.

Descriptors: *Sludge, *Mutagenicity, Industrial wastes, Wastewater treatment, Chemical treatment, Municiple wastes.

Dichloromethane extracts of sludge samples from 34 cities were tested for mutagenicity by using the Salmonella/mammalian microsome assay. Of the 34 samples, 33 demonstrated a dose-related increase in revertants in at least 1 of the 5 tester strains; of these 33 samples, 12 were positive with 2 or more strains. Seventy-six percent of the positive samples required metabolic activation to demonstrate mutagenicity, while 18% were mutagenic with and without the S-9 fraction, and 6% were mutagenic only in the absence of any metabolic activation. No association existed between the independent variables percent industrialization, wastewater treatment scheme, and chemical additives when tested individually against mutagenicity. (Author's abstract)
W84-01499

WASTE SLUDGE TREATMENT - MORE PERFORMANCE FOR LESS MONEY,
J. Warden.
Effluent and Water Treatment Journal, Vol. 23, No. 4, p 140-143, April, 1983. 3 Fig.

Descriptors: *Sludge thickening, *Hydroxide, Sludge disposal, Wastewater treatment, Polymers.

When raw water is dosed with coagulant the coagulant hydroxide is precipitated. This precipitate forms loose, open floc structure which accumulates on the filter, necessitating backwashing to clean the system. Coagulant hydroxide is exceedingly difficult to dewater, and it arises at very low concentrations, averaging about 0.08% by weight. With polyelectrolites it is possible to form large flocs which settle rapidly and achieve a high rate of solids capture. When dosed into a sludge the polymer acts very rapidly. If the flocs are very small when the polymer is dosed, the long polymer chain molecules will link across and round them. This is done in practice by pumping the flow through an orifice plate to make the flocs very small just at the point where the polymer is dosed. The sludge produced was described as containing no free water because if it was left standing for several hours it did not thicken any more and no free water appeared on the surface. It appeared that all the water which could be removed had been squeezed out by the kneading action of the thickener rake. Between 1 and 2 parts of polymer was used per thousand parts of sludge solids by weight. The first plant to use this technology was commissioned in January of 1980. The waterworks produced 2 million gallons daily and the solids load is about 450 lb/day. The works effluent at about 0.3% solid is retreated in a 5 ft diameter continuous thickener at a polymer cost of less than 50 pence per day and dewatered in a small hand operated filter press on a 4 hr cycle, two pressings per day. (Baker-IVI)
W84-01565

OPERATIONAL EXPERIENCE USING H2O2 IN LANDFILL LEACHATE TREATMENT,
Interox Chemicals Ltd., Widnes (England).
J. A. L. Fraser, and N. Tytler.
Effluent and Water Treatment Journal, Vol. 23, No. 4, p 149-156, April, 1983. 2 Fig, 6 Tab, 19 Ref.

Descriptors: *Leachates, *Landfills, *Hydrogen peroxide, *Odor control, Waste dumps, Groundwater contamination, Lagoons, Sulfates, Bacteria, Seasonal variations, Cost analysis, England.

Some of the techniques employed in gaining control of a leachate problem at the Bray-on-Thames landfill site are reviewed. The site consists of a single large quarry bounded on three sides by residential development. The central area is subdivided into lagoons which have been used for storage of contaminated water comprising raw and diluted leachate originating from the worked and reclaimed areas. Principal objectives of the restoration included the control of sulfide odor emission from lagoon surfaces; improvement in the leachate quality sufficiently to meet the discharge criteria imposed by the Thames Water Authority; implementation of remedial site engineering to seal the surrounding perimeter ditch and stem ground water ingression; removal of misplaced land drains and re-alignment of surface contours over reclaimed areas to control leachate production and improve surface runoff. Seasonal variations in quality and quantity of leachate had to be considered as well as making every effort to expend only minimal capital costs for dosing equipment. Heavy duty, portable, diesel engines, vacuum primed pumps were chosen to move the leachate mass. Sulfide odors were controlled using a well-tried technique of surface treatment calling for placement of containers of peroxide every 20 m along the upwind banks of lagoons and allowing peroxide to drip into the water at 100 ml/min. (Baker-IVI)
W84-01567

5F. Water Treatment and Quality Alteration

NITRATES CONCENTRATION REDUCTION IN DRINKING WATER: EXTRA DETAILS ON BIOLOGICAL TREATMENTS (REDUCTION DES TENEURS EN NITRATES DANS LES EAUX DE CONSOMMATION: LE POINT SUR LES TRAITEMENTS BIOLOGIQUES),
J. M. Philipot, J. Sibony, G. Martin, and G. Blecon.
Aqua, No. 2, p 61-67, April, 1983. 4 Fig, 6 Tab, 14 Ref.

Descriptors: *Water treatment, *Nitrates, *Drinking water, Denitrification, Heterotrophic bacteria, Filtration, Biological treatment, Anaerobic treatment, Organic compounds.

The presence of nitrates in drinking water is a subject of concern for the consumer. In France the Supreme Health Authority has given a favorable opinion on the development of a biological process. This method uses the properties of some bacteria in anoxic conditions, to oxidize a carbonaceous substrate, i.e. ethanol, and to reduce the nitrates to gaseous nitrogen. It is the heterotrophic pathway. High yields are obtained by cell-fixation of denitrifying bacteria on a specific mineral medium. A post treatment including an aerated filtration of G.A.C. and a sand filtration is achieved in one step through a BIOCARBONE filter: the nitrate content of the raw water is then reduced to 25 mg/l; in the same way, organics and micropollutants, often associated with nitrate pollution, are removed. Another biological treatment will soon be available; it uses the autotrophic pathway of biological denitrification. A reduced mineral substrate, i.e. granular sulfur, is used for nitrate reduction to gaseous nitrogen. A mixed bed of calibrated grains of sulfur and calcium carbonate enhances the denitrification rate. Figures are given of the results of both processes with different kinds of raw water. (Author's abstract)
W84-01458

THE USE OF ACTIVATED ALUMINA IN DRINKING WATER TREATMENT; A BIOLOGICAL REVIEW (UTILISATION DES ALUMINES ACTIVEES COMME ADSORBANT DANS UNE FILIERE DE TRAITEMENT D'EAU POTABLE: REVUE BIBLIOGRAPHIQUE-PROSPECTIVE),
Ecole Nationale Superieure de Geologie Appliquee et de Prospection Miniere, Nancy (France). Centre de Valorisation des Minerais.
J. Y. Bottero, F. Thomas, and A. Leprince.
Aqua, No. 2, p 69-73, April, 1983. 6 Fig, 4 Tab, 15 Ref.

Descriptors: *Activated alumina, *Water treatment, Drinking water, Adsorption, Regeneration, Wastewater treatment, Activated carbon, Coagulation, Polymerization, Organic compounds.

At present activated alumina cannot substitute for activated carbon. However the specific adsorption and ease of regeneration of activated alumina makes it a material worthy of deeper study. Promising applications now being investigated include the possibility of specific activation during preparation and use in combined processes with carbon or oxidation. For waste water it is possible that aluminas which are less high grade materials than activated carbons could find useful application. Activated aluminas are classified by temperature, origin, and crystalline structure. The capacity to remove mineral constituents is reported, and a summary is given of the basic aspects of the removal of organics. In this latter case the study reported from the literature concludes that adsorption on alumina is complementary to that on carbon because there is specific adsorption of polar substances and those of high molecular weight, ease of regeneration by heat or by oxidation and the possibility of surface action involving coagulation, adsorption and polymerization. Adsorption isotherms are given for activated alumina for salicyclic acid, and octylbenzene sulfonate. It was found difficult to compare these results with those for activated carbon but an isotherm for adsorption of benzoic acid on carbon is given. (Moore-IVI)
W84-01459

MANAGING COUNTYWIDE WATER SERVICES WITH SATELLITE SYSTEMS,
Economic and Engineering Services, Inc., Olympia, WA.
R. L. Wubbena, and J. M. Maxwell.
Journal of the American Water Works Association, Vol.75, No. 4, p 158-163, April, 1983. 1 Fig.

Descriptors: *Utilities, *Water utilities, Legislation, Utility management, Economic aspects, Satellite water systems, Washington.

Legislation in the state of Washington has provided the impetus for developing cooperative countywide water services. The long-term improvement program permits small satellite water systems to operate under the aegis of established utilities at the level of assistance necessary to meet regulatory requirements and to provide cost-effective, reliable service to customers. A countywide management program for operation of satellite water systems requires: identifying existing system service areas and accepting responsibility for meeting minimum standards of service; identifying small systems that do not have the management or financial resources to provide adequate service; and identifying an agency with the authority and willingness to assume the responsibility of a satellite management agency. The objective is to develop a long-term, slow-paced improvement program for small systems that will gain public support and new customers through demonstrated patience and purpose. (Moore-IVI)
W84-01518

ORGANIZING AND MANAGING SOUTH DAKOTA'S RURAL WATER SYSTEMS,
South Dakota Association of Rural Water Systems, Sioux Falls.
D. N. Davis.
Journal of the American Water Works Association, Vol. 75, No. 4, p 164-167, April, 1983.

Descriptors: *Rural areas, *Water utilities, Utilities, Economic aspects, South Dakota.

Rural water systems have been developed in South Dakota within the past 12 years to provide sufficient quantities of good water to thousands of farmers, ranchers, and small towns. Grass roots initiatives evolved into functioning water systems and cooperation among systems to improve services economically. The concept is expected to result in a growing number of systems to serve the dispersed rural population of South Dakota. (Author's abstract)
W84-01519

THE LATIN AMERICAN APPROACH TO IMPROVING WATER SUPPLIES,
Water and Air Research, Inc., Gainesville, FL.
E. G. Wagner.
Journal of the American Water Works Association, Vol. 75, No. 4, p 168-173, April, 1983. 10 Fig, 1 Tab, 1 Ref.

Descriptors: *Water treatment facilities, *Water utilities, Administration, Government finance, Costs, Design standards.

The cost of supplying water for small cities and towns in Latin America is much less than in the United States because of regional administration, methods of financing, and simplified design of treatment plants. The regional organization, whether federal or state, provides the managerial and technical skills for planning, designing, constructing, and operating water systems. Financing, usually grants, for small systems in Latin America comes from the federal and state governments. The design of treatment plants is based on obtaining the maximum production of good-quality water at the lowest possible cost. This results in minimum use of equipment and valves, maximum use of gravity, and simplification of operation. (Moore-IVI)
W84-01520

EVALUATING THE ECONOMICS OF ALTERNATIVE TECHNOLOGY FOR SMALL WATER SYSTEMS,
Weston (Roy F.), Inc., West Chester, PA.
A. K. Deb, and W. G. Richards.
Journal of the American Water Works Association, Vol. 75, No. 4, p 177-183, April, 1983. 4 Fig, 6 Tab, 4 Ref. ISP-80-15075.

Descriptors: *Water utilities, *Water management, *Economic aspects, Alternative planning, Cost analysis, Model studies.

The WATerMANagement model (WATMAN) was expanded for application to small water systems serving populations of 100-10000 so that the economics of alternative solutions to meeting new water quality standards can be evaluated. Two hypothetical cases and two actual situations were tested with the model to select preferred water supply options. In all four cases, the WATMAN model identified cost-effective solutions and competitive alternatives through a present-value analysis. The ability of the model to incorporate site-specific characteristics, to develop preliminary designs, and to make economic estimates for individual communities was demonstrated. (Moore-IVI)
W84-01521

TETRACHLOROETHYLENE LEACHED FROM LINED ASBESTOS-CEMENT PIPE INTO DRINKING WATER,
Environmental Protection Agency, Boston, MA. Water Supply Branch.
C. D. Larson, O. T. Love, Jr., and G. Reynolds, III.
Journal of the American Water Works Association, Vol. 75, No. 4, p 184-188, April, 1983. 5 Fig, 2 Tab, 2 Ref.

Descriptors: *Pipe linings, *Tetrachloroethylene, Leaching, Water distribution, Vinyl toluene liners, Flushing, Continuous bleeders, Drinking water, Water pollution sources.

Tetrachloroethylene has been detected in concentrations ranging from a few micrograms per liter to several milligrams per liter in dead ends of water distribution systems made of vinyl-toluene-lined asbestos-cement pipe. About 1600 km (1000 mi) of this lined pipe is being used, primarily in New England. Tetrachloroethylene concentrations can be lessened by flushing and installing continuous bleeders, two of the solutions being suggested to correct this organics problem, which resulted from steps to control corrosion of asbestos-cement pipe. (Author's abstract)
W84-01522

VARIATIONS IN PARTICULATE MATTER, ALGAE, AND BACTERIA IN AN UNCOVERED, FINISHED-DRINKING-WATER RESERVOIR,
Association of Bay Area Governments, Berkeley CA.
G. S. Silverman, L. A. Nagy, and B. H. Olson.
Journal of the American Water Works Association, Vol. 75, No. 4, p 191-195, April, 1983. 1 Fig, 3 Tab, 30 Ref.

Descriptors: *Drinking water, *Finished-water reservoirs, *Water quality, Particulate matter, Algae, Bacteria, Turbidity, Chlorination, Particle size, Coliforms, Copper, Iron.

Physicochemical and microbiological analyses were performed on influent and effluent samples taken from Garvey Reservoir (Los Angeles County, California). Data collected on particle counts and size distributions, total plate count, coliform bacteria, algal counts, chlorophyll, turbidity, copper, and iron were analyzed with a computerized statistical package. The quality of the influent was degraded through biological activity in the reservoir to produce a lower-quality effluent. Results indicated that algae were associated with increased turbidity and particulate levels and might enhance or support bacterial activity, including physical protection of bacteria against the effects of chlorination. (Author's abstract)
W84-01523

FREE CHLORINE VERSUS AMMONIA-CHLORINE: DISINFECTION, TRIHALOMETHANE FORMATION, AND ZOOPLANKTON REMOVAL,
R. P. Mitcham, M. W. Shelley, and C. M. Wheadon.
Journal of the American Water Works Association, Vol. 75, No. 4, p 196-198, April, 1983. 3 Fig, 6 Tab, 2 Ref.

Descriptors: *Chlorination, *Disinfection, Ammonia-chlorine, Residual chlorine, Trihalomethanes, Zooplankton, Copepods, Cladocera, Water treatment, Halogenated hydrocarbons.

The relative efficiency of ammonia-chlorine and free residual chlorine in the treatment of lowland river water was studied. The roles of these chemicals in trihalomethane (THM) formation, water disinfection, and zooplankton removal were considered. Use of ammonia-chlorine reduced THM formation by as much as 80% and did not impair water disinfection. Compared with free residual chlorine, ammonia-chlorine was more effective against Copepoda (Cyclops) but less effective against Cladocera (Daphnia and Bosmina). (Author's abstract)
W84-01524

TREATING SURFACE WATERS FOR COMMUNITIES IN DEVELOPING COUNTRIES,
United Nations Development Programme, Washington, DC. Interregional Program.
C. R. Schultz, and D. A. Okun.
Journal of the American Water Works Association, Vol. 75, No. 5, p 212-219, May, 1983. 7 Fig, 1 Tab, 7 Ref.

Descriptors: *Water treatment, *Developing countries, Coagulation, Surface water, Economic aspects, Water treatment facilities, Maintenance, Operating costs.

Water treatment plants in developing countries should use simplified technologies that require little automation or mechanization to lower capital costs significantly. Operations and maintenance should also be less costly and more suitable for local labor conditions. Only as a last resort should chemical coagulation and rapid filtration be adopted. Mechanical equipment should be limited as much as possible to that produced locally. Hydraulic devices that use gravity are preferred over motor-driven equipment. The plant must be designed to treat the raw water available. Use can be made of natural coagulants derived from plants and animals to reduce the cost of treatment. Coagulation aids are effective at high turbidity levels, with possible savings of 40-50% in alum consumption. (Moore-IVI)
W84-01526

SIMPLIFYING DESIGN OF WATER TREATMENT PLANTS FOR DEVELOPING COUNTRIES,
Water and Air Research, Inc., Gainesville, FL.
E. G. Wagner.
Journal of the American Water Works Association, Vol. 75, No. 5, p 220-223, May, 1983. 1 Tab, 1 Ref.

Descriptors: *Water treatment facilities, *Developing countries, Economic aspects, Water treatment, Operating costs.

In the developing world, there is an acute shortage of money, managerial and technical skills, skilled labor, and well-organized, stable institutions. Therefore, water treatment plants in developing countries should be low in first cost and easy and economical to operate. The development of this kind of plant begins with a search for the best water source, includes determining the most effective treatment process, and continues through designing the plant. In water treatment plant design, there must be a conscious effort to minimize equipment, to maximize the use of gravity and hydraulics in the treatment process, and to make use of labor rather than equipment in the operation of the plant wherever possible. (Moore-IVI)
W84-01527

OVERVIEW OF RURAL WATER AND SANITATION PROGRAMS FOR LATIN AMERICA,
Agency for International Development, Washington, DC. Water and Sanitation for Health Project.
D. Donaldson.
Journal of the American Water Works Association, Vol. 75, No. 5, p 225-231, May, 1983. 2 Fig, 4 Tab, 8 Ref.

Descriptors: *Developing countries, *Water treatment, *Wastewater treatment, Rural areas, Economic aspects, Training, Human populations, Administration, Financing.

Though many rural inhabitants of Latin America now have access to safe water, millions remain unserved, and increasing populations place added stress on existing systems. Improvements are still greatly needed in administration and financing of water and sanitation projects and for extensive training programs for paraprofessional rural water technicians. (Author's abstract)
W84-01528

FERRIC CHLORIDE AND ALUM AS SINGLE AND DUAL COAGULANTS,
Air Force Hospital, Wurtsmith AFB, MI.
P. N. Johnson, and A. Amirtharajah.
Journal of the American Water Works Association, Vol. 75, No. 5, p 232-239, May, 1983. 9 Fig, 1 Tab, 23 Ref.

Descriptors: *Coagulation, *Alum, *Ferric chloride, Water treatment, Wastewater treatment.

A design-and-operation diagram for Fe(III) coagulation has been developed by using empirical work and information in the literature about coagulation. This diagram is compared with a previously developed design-and-operation diagram for alum coagulation. Empirical work has shown that combining alum and ferric chlorides as dual coagulants does not result in a more effective coagulant. (Author's abstract)
W84-01529

PREOZONATION AS A COAGULANT AID IN DRINKING WATER TREATMENT,
Saunier Eau et Environnement, St. Gregoire (France).
B. M. Saunier, R. E. Selleck, and R. R. Trussell.
Journal of the American Water Works Association, Vol. 75, No. 5, p 239-246, May, 1983. 16 Fig, 5 Tab, 6 Ref.

Descriptors: *Ozonation, *Flocculation, Water treatment, Basic aluminum chloride, Turbidity, Particulates, Chemical oxygen demand, Sedimentation.

The effects of preozonation on the treatment of Seine River water were evaluated in a pilot plant consisting of flocculation with basic aluminum polychloride (PAC) followed by sedimentation. Preozonation significantly increased the removals of turbidity, particle numbers and volumes, chemical oxygen demand, and UV absorbance at all treatment levels investigated (0.3-1.2 mg/L for ozone, and 15-60 mg/L for PAC), with the optimum ozone dose appearing to be about 0.8 mg/L. The favorable effects of ozone increased with pH and the particle count of the untreated water. The increases in particle removals appeared to stem partly from increases in floc size and settling velocity. (Author's abstract)
W84-01530

USING BY-PRODUCTS OF AN IRON REMOVAL PROCESS TO IMPROVE WATER TREATMENT,
Curry and Associates Engineers, Inc., Nashville, IL.
M. D. Curry, and M. Reynolds.
Journal of the American Water Works Association, Vol. 75, No. 5, p 246-248, May, 1983. 2 Fig, 3 Tab, 7 Ref.

Descriptors: *Water treatment, *Iron, *Manganese, Oxidation, Coagulation, Backwash reclamation, Corrosion, Hydrogen ion concentration, Potassium permanganate, Ferric hydroxide.

A conventional treatment for removing iron and manganese from groundwater was used by the village of Roxana, Ill., but the process did not reduce concentrations of these metals to recommended maximum levels. After using temporary measures, the village began looking at several long-term alternatives to solve the water quality problems. Of the alternatives considered, oxidation and removal of manganese with potassium permanganate was investigated further in bench studies. Modification of full-scale treatment effected the removal of manganese by using permanganate feed, ferric hydroxide from the reaction basin as a primary coagulant, and a cationic polymer as a coagulant aid. Reclamation of backwash eliminated a potential problem with disposal of the backwash. Both manganese and iron were reduced to acceptable levels. In addition, the increase in pH helped decrease corrosive water conditions in the distribution system, and the duration of filter runs was lengthened. (Author's abstract)
W84-01531

REMOVING NONVOLATILE ORGANIC CHLORINE AND ITS PRECURSORS BY COAGULATION AND SOFTENING,
Los Angeles County Sanitation Districts, Whittier, CA.
D. E. Johnson, and S. J. Randtke.
Journal of the American Water Works Association, Vol. 75, No. 5, p 249-253, May, 1983. 9 Fig, 5 Tab, 26 Ref. NSF-ENG-7908187.

Descriptors: *Chlorinated hydrocarbons, *Coagulation, *Water softening, Chlorination, Water treatment, Organic matter, Alum, Lime, Fulvic acid, Total organic chlorine, Chloroform, Hydrogen ion concentration.

Chlorine added to a potable water supply for disinfection will react with naturally occurring and anthropogenic organic matter present in the water to form volatile and nonvolatile halogenated organic by-products that represent a potential health hazard. In order to evaluate the potential of conventional water treatment to remove nonvolatile organic chlorine and its precursors, samples of groundwater, surface water, secondary effluent, and fulvic acid were treated in laboratory experiments by alum coagulation and lime softening in conjunction with prechlorination and postchlorination. Coagulation and softening both removed significant amounts of nonvolatile organic chlorine, precursors of organic chlorine, and total organic carbon (TOC). Organic chlorine precursors were removed as well as or better than TOC and much better than the organic chlorine formed during prechlorination. The increase in pH during lime treatment hydrolyzed a significant fraction of the nonvolatile organic chlorine, releasing chloroform and other by-products. (Moore-IVI)
W84-01532

USING BACKWASHING KINETICS TO EVALUATE ATTACHMENT MECHANISMS AND FORCES DURING FILTRATION,
SWEHELL Co. Ltd., Athens (Greece).
G. Toregas.
Journal of the American Water Works Association, Vol. 75, No. 5, p 254-260, May, 1983. 8 Fig, 3 Tab, 6 Ref.

Descriptors: *Filtration, *Coagulation, Backwash, Kinetics, Deep-bed filtration, Alum, Particle size, Mathematical models, Particle agglomeration, Filters.

A method is offered for evaluating the various models involved in particle removal from water by means of deep-bed filtration. Based on backwashing kinetics, this method takes into account the mechanisms associated with particle attachment (with and without alum treatment), particle agglomeration, and particle detachment. When the particle to grain size ratio (dp/dm) is greater than 0.055 straining appears to be important. For dp/dm ratios between about 0.040 and 0.055, straining appears to be significant; at dp/dm ratios below about 0.040, straining apears to be insignificant. The contribution of particle-medium interactions to the overall filter deposit was about constant (35% of total particle removal), whereas the contributions of the particle-particle interactions appears to depend on whether straining is significant. For filtration to be effective, particle-particle interactions should be predominant (accounting for as much as 65% of the total particle removal). The relative magnitude of attachment forces associated with collisions between particles and filter grains and with the formation of agglomerates resulting from alum treatment prior to filtration was evaluated by using backwashing recovery data. The attachment force acting during formation of an agglomerate depends on size rather than zeta potential. (Moore-IVI)
W84-01533

CONDENSATE POLISHING,
J. R. Emmett.
Effluent and Water Treatment Journal, Vol. 23, No. 6, p 241-243, June, 1983. 4 Fig, 4 Ref.

Descriptors: *Water treatment, *Condensates, Resins, Contamination, Design criteria, Powerplants, Water quality control, Cooling water.

Condensate polishing refers to the purification of power station turbine condensate to ensure a treated water quality which is acceptable as feed water to modern high pressure steam plants in the power generation industry. The main danger is the ingress of cooling water into the condensate. This can be a major problem as a condenser ages due to erosion or corrosion, bringing about pinhole perforations in the tube material. A second source of condensate contamination can be due to maloperation of the power station make-up plant, permitting incorrectly treated make-up water into the feed system. A further problem may be the solution of atmospheric carbon dioxide in the feed water storage tanks. Soluble impurities may also be present. Polishing equipment is to remove both soluble and insoluble impurities. The tendency is to use the mixed bed deionization process, comprised of an intimate mixture of cation and anion exchange resins. The avoidance of regenerant cross contamination is a matter of engineering design. It is highly undesirable to introduce chemical regenerants into a turbine room because of the danger of boiler feed-line contamination. Because high flows rates are used in the condensate polishing process, the bed depth has to be limited in order that the pressure loss across the plant is maintained at a satisfactory value. The degree of resin cross contamination is very much influenced by changes in resin charge volume. Such changes mean that the cation/anion interface level after separation varies in respect to the level of the anion resin take-off point and sluicing jet position. To solve the problem of resin cross contamination, Kennicott developed the Consep system, in which a very high degree of resin separation is achieved. (Baker-IVI)
W84-01575

THE INTERPRETATION OF COMPLEX CHROMATOGRAMS BY COMPUTER ANALYSIS,
Anglian Water Authority, Huntingdon (England).
For primary bibliographic entry see Field 5A.
W84-01673

WATER DECHLORINATION BY ACTIVATED CARBON, ULTRAVIOLET RADIATION AND SODIUM SULPHITE; A COMPARISON OF TREATMENT SYSTEMS SUITABLE FOR FISH CULTURE,
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
M. A. Giles, and R. Danell.
Water Resources, Vol. 17, No. 6, p 667-676, June, 1983. 4 Fig, 5 Tab, 21 Ref.

Descriptors: *Dechlorination, *Activated carbon, *Ultraviolet radiation, *Sodium sulfite, Water treatment, Filtration, Pilot plant, Municipal water, Toxicity, Chlorine, Halogenated hydrocarbons.

Many research facilities rely on municipal water supplies as a source of dilution water for aquatic toxicity investigations or for rearing and study of aquatic organisms, but chlorine, commonly employed as a disinfectant, is highly toxic to many freshwater organisms. The characteristics of water dechlorination by activated carbon filtration, u.v. irradiation and sodium sulfite injection were examined. A pilot plant water treatment system composed of sand and diatomaceous earth filtration,

ozonation and activated carbon filtration was evaluated. Activated carbon did not completely eliminate chlorine under any conditions tested but the post-carbon chlorine concentrations were relatively insensitive to large variations in incoming chlorine levels and water flow rates. Carbon filtration also reduced total dissolved organic carbon concentrations by 65% and reduced various halogenated methane derivatives by 97-100%. Ultraviolet irradiation eliminated up to 99% of the total chlorine in municipal water but u.v.-dechlorination was sensitive to flow rate with a rate constant of 2.02/min between 10 and 271/min. Water temperatures ranging from 7.5 to 20.6 C did not affect the efficiency of dechlorination by activated carbon or u.v. irradiation. Sodium sulfite at a 3:1 molar ratio to chlorine completely eliminated chlorine from municipal water while a sulfite:chlorine ratio of 6:1 was required to completely dechlorinate water which had been partially dechlorinated by activated carbon. (Moore-IVI)
W84-01681

RELATIONSHIP OF BACTERIAL COUNTS WITH TURBIDITY AND FREE CHLORINE IN TWO DISTRIBUTION SYSTEMS,
J. K. Reilly, and J. S. Kippin.
Journal of the American Water Works Association, Vol. 75, No. 6, p 309-312, June, 1983. 6 Tab, 49 Ref. EPA grant R804724010.

Descriptors: *Water distribution, *Bacteria, *Turbidity, *Free chlorine, Drinking water, Water quality standards, Public health, Coliforms, Ecosystems, Encapsulation, Massachusetts, Salem, Beverly.

The two separate and distinct water distribution systems of Salem and Beverly, Massachusett, which have a common history and have met the US Public Health Services standards for a common carrier since 1935, were comprehensively studied to determine if certain aspects of the drinking water standards adequately controlled the quality of finished water in the distribution system. The sampling points in both cities were faucets in public buildings located near the middle and ends of each distribution system. A total of 2409 samples was collected over a 23 month period: 1157 samples from Salem, 1056 samples from Beverly, and 196 samples from the filtration plant used by both cities. The diversity of organisms identified by using standard plate count (SPC) and membrane filtration strongly suggests an established microbial ecosystem in two distribution systems. The SPC exhibited no relationship with coliform count when the SPC was less than 50 organisms/ml. The SPC was not dependent on low-level turbidity and varied with respect to free chlorine residuals. The frequency of coliform isolation was independent of turbidity and free chlorine. Specifically, encapsulated coliforms (Klebsiella pneumoniae, Enterobacter cloacae, E. aerogenes, and E. agglomerans), which gave typical coliform results, exhibited the ability to survive a free chlorine residual of 0.2 mg/l or more. Encapsulation was a major factor in all of these results. (Moore-IVI)
W84-01754

5G. Water Quality Control

NITRATE IN BRITISH WATERS,
National Water Council, London (England).
R. J. White.
Aqua, No. 2, p 51-57, April, 1983. 6 Fig, 27 Ref.

Descriptors: *Nitrate, *Water quality control, Great Britain, Standards, Water pollution sources, Drinking water, Human diseases, Methemoglobinemia.

Health risks and water quality standards are discussed for nitrate. The origin of nitrate in water is reviewed as a background to rising concentrations in both rivers and groundwater. The identified health risk which was noted in the 1974 IWSA International Standing Committee on Water Quality and Treatment Report was methemoglobinemia. Since that time the incidence of this problem has become rarer in Great Britain. Nitrate concentrations in both rivers and groundwater sources have been increasing and the problems could become worse before equilibrium is reached. The principal cause is changes in farming practices to enhance agricultural productivity. Opportunities for controlling nitrate sources are limited. Water treatment processes have been developed with a view to keeping nitrate concentrations in public supplies below 50 mg/l NO3. The viability of ion exchange has been established and problems in biological denitrification are being overcome. There is a possibility of substantial expenditure being required to reduce nitrate concentration but steps to deal with the problems in public supplies are well in hand. In Britain about 99% of the population receives water from the public supply systems. The most significant risks attached to nitrate lie with the small minority who rely on private supplies from shallow wells. (Baker-IVI)
W84-01456

NITRATE IN THE NETHERLANDS - A SERIOUS THREAT TO GROUNDWATER,
Rijksinstituut voor Drinkwatervoorziening, Leidschendam (Netherlands).
W. V. Duyvenbooden, and J. P. G. Loch.
Aqua, No. 2, p 59-60, April, 1983. 1 Tab, 4 Ref.

Descriptors: *Nitrate, *Groundwater pollution, Water quality, Netherlands, Agricultural runoff, Soil properties, Drinking water, Fertilizers.

A nitrate problem exists in the Netherlands, in the sandy regions of the country located in the eastern and southern parts. Nitrate concentrations in the groundwaters are gradually rising, primarily due to agricultural activities. Particular in the bio-industrial areas, extremely high nitrate levels are found, extending deeply where there are aerobic conditions. A gradual deterioration has been detected in the quality of the groundwater. Without special measures being taken it is expected that in many cases nitrate levels in groundwater will in the long run rise above the European standards for drinking water. Serious attention will have to be given to measures to secure the supply of groundwater of a sufficient quality with respect to nitrate. At present no national regulations exist on the use of manure and fertilizers to protect groundwater. Some regional regulations have in principle the possibility of restricting the use of nitrogen in the protection zones around groundwater pumping stations, but in practice these rules are seldom complied with. (Baker-IVI)
W84-01457

NITRATE IN WATERS FOR HUMAN CONSUMPTION: THE SITUATION IN FRANCE (1979-1981). A STUDY BY THE FRENCH MINISTRY OF HEALTH, (TENEUR EN NITRATE DES EAUZ DESTINEES A LA CONSOMMATION HUMAINE: LA SITUATION EN FRANCE (1979-1981). ETUDE REALISEE PAR LE MINISTERE DE LA SANTE FRANCAIS: CADRE DE L'ETUDE).
Aqua, No. 2, p 74-78, April, 1983. 2 Fig, 7 Tab.

Descriptors: *Nitrates, *Groundwater, *Drinking water, *Regulations, France, Agricultural runoff, Well water, Groundwater contamination.

The French Ministry of Health has issued instructions on the attitude to be taken in regard to the presence of nitrate in drinking water. A survey was performed which revealed that 81% of the population has nitrate levels less than 25 mg/l and 96% to 98% has levels less than 50 mg/l in their drinking water supplies. Out of 53 million people approached in the survey, 280,000 at most have a water supply which exceeded 100 mg/l of nitrate at least once in the last three years. Out of the 20,000 distribution units surveyed about 1000 had nitrate above 50 mg/l and 61 only were about 100 mg/l. Most of the high nitrate areas were in the North and West of metropolitan France. Most of the high nitrates are found in groundwater, and most of the wells affected were in highly developed agricultural areas. Treatment by activated carbon is very effective but costly particularly because of regeneration whose frequency depends on speed of saturation of the carbon and thus on its place in the sequence of treatment. Based on a study of the physical chemical characteristics of aluminas suitable for industrial use, it is concluded that activated alumina cannot fulfil the role of activated carbon for drinking water quality control. However, because of the specific adsorption capacity and the ease of regeneration the use of activated alumina for the removal of organics is a subject which must be pursued. The possibility of specific activation during alumina preparation or alumina-carbon methods or alumina in oxidation treatment should be considered. (Baker-IVI)
W84-01460

INTERACTION OF CLAY SOILS WITH WATER AND ORGANIC SOLVENTS: IMPLICATIONS FOR THE DISPOSAL OF HAZARDOUS WASTES,
Texas Tech Univ., Lubbock. Dept. of Civil Engineering.
W. J. Green, G. F. Lee, R. A. Jones, and T. Palit.
Environmental Science and Technology, Vol. 17, No. 5, p 278-282, May, 1983. 4 Fig, 2 Tab, 13 Ref.

Descriptors: *Clays, *Land disposal, *Hazardous materials, Waste disposal, Organic solvents, Partition, Interstitial water, Soil dehydration, Clay liners.

Studies of the behavior of three compacted, moist clay soils when immersed in water and in organic solvents have been conducted. The correlation between the logarithm of the octanol-water partition coefficient (log Kow) and the percent swelling of the clay soil suggests that swelling in these systems depends upon the transfer of immersion fluid into the clay soil pore waters. X-ray diffraction data obtained on air-dried clay soils treated with various liquids indicate that interlayer expansion does not occur in these systems. Slight shrinkage of clay soils in apolar, hydrophobic solvents such as carbon tetrachloride and xylene indicates that these liquids could damage the integrity of clay liners used for hazardous waste disposal pits. On the basis of these results, it is recommended that laboratory shrink-swell testing be conducted on samples of clay liners and representative waste mixtures and soils of the type to be encountered at a storage site. (Author's abstract)
W84-01500

SEEPAGE FROM OILFIELD BRINE DISPOSAL PONDS IN UTAH,
Colorado Univ. at Boulder. Dept. of Geological Sciences.
For primary bibliographic entry see Field 5B.
W84-01552

ORGANIC MICROPOLLUTANTS IN WATER - A WHO VIEWPOINT,
J. I. Waddington.
Effluent and Water Treatment Journal, Vol. 23, No. 4, p 145-148, April, 1983. 1 Tab, 10 Ref.

Descriptors: *Hazardous materials, *Organic compounds, Toxicity, Quality control, Water quality, Guidelines, Regulations.

An increasing number of organic micropollutants are reaching the aquatic environment via sewage treatment plants and from industrial and agricultural activities. For many years the World Health Organization (WHO) has been developing health criteria related to the toxicity of chemical substances. Absolute safety is an impossible goal in relation to any aspect of life and a careful approach to risk assessment, cost-benefit and priority setting must be adopted if the major problems are to be satisfactorily overcome. The relationship between exposure and the spectrum of effects is referred to as the dose-response and an understanding of this relation constitutes a base for the study of toxicity. Dose-response curves have been developed for many chemicals, permitting the development of acceptable daily intakes (ADI) based on the non-observable adverse effects (NOAE) level. A problem with this approach lies with the duration of the NOAE level. There is uncertainty as to how long

such an intake can be tolerated without subsequent damage being sustained. (Baker-IVI)
W84-01566

EFFECT OF LOW LEVELS OF EXCHANGEABLE SODIUM AND APPLIED PHOSPHOGYPSUM ON THE INFILTRATION RATE OF VARIOUS SOILS,
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Inst. of Soil and Water.
Z. Kazman, I. Shainberg, and M. Gal.
Soil Science, Vol. 135, No. 3, p 184-192, March, 1983. 6 Fig, 1 Tab, 14 Ref.

Descriptors: *Infiltration rate, *Sodium, *Soil crust, Arid regions, Lime, Phosphogypsum, Rain, Soil surface, Calcium carbonate, Soil solution, Electrolytes, Soil aggregates, Soil chemistry, Israel.

The arable soils in the arid and semiarid regions of Israel contain 2 to 6% exchangeable sodium in the upper layer. Considerable amounts of runoff and erosion from these soils, measured during rainstorms, have been associated with aggregate dispersion and crust formation at the soil surface. The effect of exchangeable sodium percentage (ESP) on the infiltration rate (IR) and crust formation of four soils, varying in their texture, mineralogy, and CaCO3 content was studied, using distilled water (EC approximately .05 mmho/cm) in a rain simulator. The IR of the four soils was very sensitive to low levels of ESP (5), whereas the hydraulic conductivity (HC) of these soils was less sensitive. The presence of lime in the soils was effective in preventing HC decreases due to low levels of exchangeable Na. Conversely, lime was not effective in maintaining the IR of the calcareous soils. Phosphogypsum prevented the sharp drop in IR of the soils at all levels of ESP. The mechanical impact of the raindrops, the low concentration of electrolytes in the rain and in the surface soil solution, and the relative freedom for particle movement at the soil surface accounts for the higher susceptibility of the soil surface to exchangeable Na. The high rate of dissolution of phosphogypsum, leading to the presence of electrolytes in the surface soil solution, accounts for the effectiveness of phosphogypsum in maintaining the high IR. The effect of low levels of ESP and the soil solution concentration of the IR of soils suggests that crust formation in soils is due to two mechanisms: a physical dispersion of soil aggregates caused by the mechanical impact of the raindrops; and a chemical dispersion caused by the soil ESP and the low electrolyte concentration in the applied water. (Moore-IVI)
W84-01597

THE INFLUENCE OF THE INITIAL WATER CONTENT ON THE REDISTRIBUTION OF SOIL WATER AFTER INFILTRATION,
Agricultural Coll. of Athens (Greece). Lab. of Agricultural Hydraulics.
A. Poulovassilis.
Soil Science, Vol. 135, No. 5, p 275-281, May, 1983. 5 Fig, 15 Ref.

Descriptors: *Soil water, *Infiltration, *Redistribution, Wetting boundary, Drying boundary, Hysteresis loop.

The effect of the initial soil water content prevailing in a porous column before the initiation of an infiltration-redistribution cycle on the redistribution rate was studied both theoretically and experimentally. The initial water content may vary following either the drying boundary or the wetting boundary curve of the hysteresis loop involved in the infiltration-redistribution process. The redistribution rate for initial states on the drying curve is greater than that for states on the wetting boundary curve. An increase of the initial water content along the drying curve may result in an increase of the redistribution rate, though an increase along the wetting curve may result in a decrease of the redistribution rate. The development of the redistribution pressure head profiles was followed in a 55 cm long tube packed uniformly with beach sand to give a porous body characterized by the hysteretic relationships between soil water content and pressure head. The experimental results support the theoretical conclusions. (Moore-IVI)
W84-01599

THE ROLE OF AIR AND WATER RESIDUALS FOR STEAM ELECTRIC POWER GENERATION,
North Carolina Univ. at Chapel Hill. Dept. of Economics.
N.-B. Tran, and V. K. Smith.
Journal of Environmental Economics and Management, Vol. 10, No. 1, p 35-49, March, 1983. 3 Tab, 39 Ref.

Descriptors: *Water pollution control, *Steam electric powerplants, *Cost analysis, Electric power industry, Regulation, Policy, Industrial wastewater, Effluent, Economic aspects, Mathematical models.

An attempt was made to treat atmospheric and waterborne residuals as joint outputs with electricity in modeling the ex post production technology for steam generating electric power plants. Using a joint output cost function, the findings support the inclusion of these measures in the cost functions for all vintages of the power plants. They suggest that the residual outputs cannot be treated as separable from the variable inputs with any of these vintages. Measured input substitution in previous studies may not accurately reflect the features of the expost technology. These findings also have direct implications for policy concerns. The control of atmospheric and waterborne residuals will necessarily affect the optimal allocation of factor inputs. This suggests that the ex post technology for steam electric generation embodies a response pattern to environmental regulation that is similar to that of ex ante design analyses: in both cases, it can be expected that the adjustments to environmental controls will not be neutral in their effects on factor input usage. Of course, there are likely to be substantial differences between ex ante and ex post technologies in the actual nature of these effects. (Moore-IVI)
W84-01605

POLLUTION CONTROL AND INPUTS TO PRODUCTION,
Tennessee Technological Univ., Cookeville. Dept. of Management, Marketing and Economics.
K. W. Ketkar.
Journal of Environmental Economics and Management, Vol. 10, No. 1, p 50-59, March, 1983. 1 Fig, 1 Tab, 11 Ref.

Descriptors: *Water pollution control, *Industrial wastwater, *Cost analysis, Labor, Capital, Chemical industry, Electrical industry, Oil industry.

The inputs required for air, water, and solid waste pollution abatement in the United States are identified. Industry level data on pollution abatement expenditures in 1976 are broken down into expenditures on various intermediate inputs and on two primary inputs - labor and capital. The 1971 input-output table is adjusted to reflect the input needs of pollution abatement technology. This revised direct input coefficients matrix is used to derive the gross output and primary input requirements of the 1971 final bill of goods. Pollution abatement technology requires inputs from some industries such as chemicals, electricity, and petroleum products, which are highly polluting. This implies that in the process of abating pollution, more pollution will be generated. By using the adjusted input-output matrix, the effect of current (operating) pollution abatement expenditures on the gross outputs of polluting industries, industries supplying inputs for pollution abatements, and other industries are determined. Directly and indirectly roughly 124,000 new jobs would be created per 1 billion dollars of direct pollution abatement expenditure. (Moore-IVI)
W84-01606

OPTIMAL INVESTMENT TO REDUCE THE DECAY RATE OF AN INCOME STREAM: THE CASE OF SOIL CONSERVATION,
California Univ., Davis. Dept. of Agricultural Economics.
R. A. Collins, and J. C. Headley.
Journal of Environmental Economics and Management, Vol. 10, No. 1, p 60-71, March, 1983. 4 Fig, 4 Tab, 11 Ref.

Descriptors: *Soil conservation, *Investment, *Farming, Soil management, Erosion, Costs, Subsidies, Capital, Iowa.

Some natural resource investments are unique from a capital theory point of view because they do not create a new income stream, but rather alter the rate of change of an existing stream of income or social benefit. A firm level model is presented for choice of optimal expenditures for soil conservation capital. The model suggests that the optimal decay rate of income due to soil loss depends on current farm income, the interest rate, and the cost effectiveness of soil conservation capital. Data from southern Iowa were used to demonstrate that farmers in the same area may rationally behave differently when faced with a government subsidy program for conservation. The model gives a basis for calculating the private internal benefits of soil conservation capital and, therefore, a basis for predicting behavior. (Moore-IVI)
W84-01607

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

RESERVOIR MANAGEMENT: A RELIABILITY PROGRAMMING APPROACH,
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 4A.
W84-01703

6B. Evaluation Process

ALTERNATIVE POLICY INSTRUMENTS UNDER UNCERTAINTY: A PROGRAMMING MODEL OF TOXIC POLLUTION CONTROL,
Meta Systems, Inc., Cambridge, MA.
For primary bibliographic entry see Field 5D.
W84-01609

WATER RESOURCE AND THE ENVIRONMENT: DEVELOPMENT PLANNING IN BRAZIL,
Brazilian National Committee on Large Dams, Sao Paulo.
For primary bibliographic entry see Field 6G.
W84-01629

USE OF THE METHOD OF MULTIPURPOSE OPTIMIZATION FOR ECONOMIC JUSTIFICATION OF HYDROPOWER INSTALLATIONS,
V. R. Okorokiv, and D. S. Shchavelev.
Hydrotechnical Construction, Vol. 16, No. 10, p 571-575, October, 1982. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 10, p 32-34, October, 1982.

Descriptors: *Economic justification, *Dam construction, *Mathematical studies, Water management, Water resources development, Powerplants, Systems analysis.

The systems approach is frequently used when justifying the construction of hydropower installations. In this approach the hydropower station is regarded as a component of electric power and water management systems. The systems approach consists in combined consideration of all national economic consequences due to internal and external, direct and inverse relations of these systems. Methods and models of solving optimization problems in power engineering and water management use the minimum of adjusted expenditures as the

criterion. This method is based on a bottom-level evaluation of the properties of the systems. The method of adjusted expenditures makes it possible to determine the comparative effectiveness of competing variants on the basis of analyzing the input characteristics-capital investments and annual outlays adjusted to the same dimension by means of the standard cost-effectiveness ratio. The multipurpose optimization method is more general than the method of minimum adjusted expenditures. If all expenditures needed for attaining several purposes can be expressed in terms of adjusted expenditures and the social consequences of realization of all variants are practically the same, then the same variant will be the most effective both by the multipurpose optimization method and by the method of minimum adjusted expenditures. (Baker-IVI)
W84-01741

6D. Water Demand

ESTIMATION OF WATER DEMANDS USING DEFICIT ANALYSIS,
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
R. M. Clark, J. A. Goodrich, and J. I. Gillean.
Journal of Water Resources Planning and Management, Vol. 109, No. 4, p 271-286, October, 1983. 8 Fig, 8 Tab, 12 Ref.

Descriptors: *Water demand, *Water resources development, Reservoir sizing, Streamflow, Deficit analysis, River basin development.

Competition for water among governmental entities with common river systems has become increasingly fierce. This competition will no doubt become even more fierce as populations continue to grow and become increasingly dispersed. One of the major issues involved in water resource availability is the construction of reservoirs to provide continuous and dependable water supply. Historically, the approach to reservoir 'sizing' is based on comparing the lowest historical system flow against the highest water demands anticipated. More recently stochastic techniques have been used to estimate water yield. This paper uses a technique, 'deficit analysis,' that matches available flow versus actual and/or projected demands. If demand exceeds available flow, a deficit occurs that must be satisfied by flow augmentation or reservoir capacity. Standard techniques such as the Ripple procedure or routing techniques can reveal total amounts of water required. By studying the shape and timing of deficits important additional design information can be gained. The technique is applied in a case study context to reservoir selection in the Washington D.C. Metropolitan Area. (Author's abstract)
W84-01465

ARIZONA'S WATER STRATEGY: BRING MORE IN AND RESTRICT ITS USE,
A. Morrison.
Civil Engineering, Vol. 53, No. 4, p 46-49, April, 1983. 4 Fig.

Descriptors: *Water demand, *Water supply development, *Groundwater management, *Legislation, Water supply, Regulations, Water management, Subsidence, Arizona.

Large crevices suddenly appeared in the Arizona earth near Phoenix and Tucson in the fall of 1982 due to decades of pumping groundwater out at a rate far greater than the natural rate of replenishment. The major use of this water was agriculture which uses 89% of all the water consumed in the state. The state's 1980 Groundwater Management Act provides for a state-managed reduction in the percentage of available water to be used by agriculture. The Act is the first in any state to limit the pumping of groundwater. The Act sets management goals for the biggest problem areas of the state, Phoenix, Tucson, and Prescott metropolitan areas and the primarily agricultural areas of Pinal County. The goal for the cities is safe yield, which is defined as the maintenance of a balance between groundwater withdrawals and groundwater recharges by January 2025. After 2005, using powers granted by the Act, the state will buy up and retire farmland as needed to restore water balance. To restore and achieve the eventual balance of water supply and demand, agricultural usage will have to be reduced to between 65 and 70%. A groundwater withdrawal fee or pump tax will be imposed to help defray costs of the program. Another important and controversial provision of the law is one which will effectively discourage real estate development in areas of the state where ground water supply is inadequate. (Baker-IVI)
W84-01479

MANAGING RAFTING RIVERS,
Abt Associates, Inc., Cambridge, MA.
D. Berry, C. Cox, and P. Wolff.
Water Spectrum, Vol. 15, No. 1, p 10-17, Spring, 1983. 5 Fig, 2 Tab.

Descriptors: *Recreation demand, *Water use, *Water management, *Rafting, Wilderness, Recreation facilities, Environmental effects, Aesthetics.

In the northeast, conflicts are now arising from large-scale rafting and these are beginning to face recreation and natural resource agencies. This is especially true considering the prevalence of rafting on scenic rivers in primitive woodland environments. Management considerations fall roughly into five categories: launch and take-out characteristics which determine the number of launches which can effectively be handled by a site in a given period of time; launching hours, determining the number of launches which can be made in a given day; number of raftable days, determined by numbers of weekend days and holidays which fall during the rafting season; lunch or break site factors, which are determined by the number of launches being made from one point during the day; and conflicts with other activities such as anglers, canoeists, campers, and with traffic on the roads near the river. Management strategies call for the adoption of a river recreation management plant, the application of land use controls along the river, the imposition of use limits, the requirement of obtain access or other permits, the certification of guides and imposition of safety requirements, and the control of river flow. In order to manage effectively, those responsible for management must have a solid data base documenting point of congestion, environmental damage, conflicts with other recreation activities, and detraction from the aesthetic aspects of rafting by crowding. (Baker-IVI)
W84-01639

CAPACITY EXPANSION MODEL FOR LARGE-SCALE WATER-ENERGY SYSTEMS,
International Engineering Co., Inc., San Francisco, CA.
J. Matsumoto, and L. W. Mays.
Water Resources Research, Vol. 19, No. 3, p 593-607, June, 1983. 13 Fig, 11 Tab, 9 Ref.

Descriptors: *Energy, *Water resources development, *Mathematical models, *Resources development, Computer models, Water demand, Capacity, Optimization.

Development of new energy facilities can be constrained by the availability of raw energy and water resources as well as the location of major demand centers for these resources. A mathematical optimization model has been developed to help investigate alternatives for the capacity expansion of water-energy systems. The system consists of four subsystems: water, coal, electricity, and gas systems. Expressing new capacities, production, and distribution activities mathematically, the mathematical structure of the problem is defined and formulated as a multisystem, multiperiod capacity expansion problem. A major emphasis in development of this model was to handle very large scale systems. Benders decomposition is applied to the original problem to decompose it into three problems: capacity, production, and distribution problems. Each problem is solved by specialized algorithms. An example problem was solved. The computer code, CAPX1, for the capacity expansion of water-energy systems consists of approximately 7000 Fortran statements. The code is dimensioned to handle a water-energy system of 240 new projects, 50 existing facilities, 3 time periods, and for each subsystem, 400 nodes and 1000 arcs. (Moore-IVI)
W84-01701

6E. Water Law and Institutions

LAND APPLICATIONS OF WASTEWATER: WATER RIGHTS ISSUES,
Western States Water Council, Salt Lake City, UT.
C. Bell, W. E. Cox, and G. Fiedler.
Journal of Water Resources Planning and Management, Vol. 109, No. 4, p 287-302, October, 1983. 25 Ref.

Descriptors: *Land disposal, *Water rights, *Wastewater disposal, Legal aspects, Water use, Return flow, Appropriation, Riparian rights, Municipal wastewater, Effluents.

Land application of municipal effluents is encouraged by existing federal water quality legislation and regulations as an alternative to conventional surface water discharge of partially treated effluent. However, conversion to the land application approach may impact downstream water users since the associated operations are likely to increase water consumption or change the location of return flows, or both. The legal status of such changes must be evaluated by application of state water law. In the western United States, the doctrine of prior appropriation protects appropriators whose water rights depend on return flows of prior appropriators by restricting changes in the manner in which the prior rights are exercised. In the East, the riparian doctrine sets limits on the amount of water consumption and place of water use. Although there is little direct precedent interpreting the principles of the two doctrines in relation to land application, potential constraints exist. This paper evaluates the significance of these constraints and the possible impact of water law on the adoption of the land application technique. (Author's abstract)
W84-01466

SOIL EROSION: ECONOMIC AND TECHNOLOGICAL INTERFACES,
Department of Agriculture, Washington, DC.
For primary bibliographic entry see Field 4D.
W84-01611

TRANSFERABLE DISCHARGE PERMIT TRADING UNDER VARYING STREAM CONDITIONS: A SIMULATION OF MULTIPERIOD PERMIT MARKET PERFORMANCE ON THE FOX RIVER, WISCONSIN,
Colby Coll., Waterville, ME. Dept. of Economics.
W. B. O'Neil.
Water Resources Research, Vol. 19, No. 3, p 608-612, June, 1983. 5 Tab, 4 Ref.

Descriptors: *Permits, *Water pollution control, Legislation, Model studies, Water quality, Cost analysis, Water temperature, Flow, Regulation, Wisconsin, Fox River.

The state of Wisconsin has recently established the legislative basis for what may be the first, operating water-pollution permit market in the United States. A multiperiod water quality planning model is developed to illustrate the performance of a TDP market under conditions of varying stream flow and temperature. The model is applied to the case of the Fox River and is used to compare the cost of achieving target water quality levels under conventional regulatory rules with the cost associated with operation of a TDP market. In addition to the cost estimates, the simulation of market performance yields information on the probable pattern of trading that may occur in the Fox River TDP market. The traditional rules for abatement allocation were about 40% more costly than the minimum-cost potential market solution. Under the worst case flow-temperature scenario the analysis showed that up to $7 million could be spent annu-

ally on the management of a market before the market would be a less-preferred strategy. The market could exhibit inefficiencies as a result of a lack of information or imperfect competition that would reduce the cost differential until a $6 million difference vanished. The empirical analysis of the Fox River provides strong support for further consideration of the permit market idea. (Moore-IVI)
W84-01702

6F. Nonstructural Alternatives

WATER SUPPLY,
D. P. Sheer.
Civil Engineering, Vol. 53, No. 6, p 50-53, June, 1983. 2 Fig.

Descriptors: *Water supply management, *Water supply development, Water demand, Water supply, Washington, D.C., Virginia, Maryland, Design criteria, Water management.

Cooperative water supply agreements for the Washington, D.C. metropolitan area, based on state-of-the-art water resources management techniques, have ended a 30 year search for solutions to the region's recurring water shortages. Implementing these innovative operating procedures required eight separate agreements among agencys including the US Army Corps of Engineers, the states of Maryland and Virginia, the District of Columbia, two local utilities, and the Interstate Commission on the Potomac River Basin. The agreements are based primarily on almost costless, cooperative, improved operations of existing facilities, using state of the art flow and daily demand forecasting techniques. Construction of one small local reservoir, $30 million, is included, but that is not so much needed for the quantity of water it will hold as for the additional operational flexibility it provides. Overall system yield has been increased by nearly 50% and individual project yields by as much as 200%. Engineering achievements in the system include: the combination of optimization and simulation techniques to provide practical rules for operation of the entire system: the first large scale implementation of the National Weather Service River Forecast System, the development and implementation of a technique to predict water demand and the application of that technique in water source system design and operation; the combination of distribution analysis and hydrologic modeling to develop operating procedures for a complex water distribution system; the use of risk analysis to identify the start of potential droughts and to quantify the risks of continued drought: and the use of drought games to test and improve the water supply operating procedures and to illustrate the use of those procedures to decision makers, and the use of a small local reservoir to augment the yield of upstream impoundments. (Baker-IVI)
W84-01482

IMPROVED FLOODPLAIN MANAGEMENT CAN BE COST-EFFECTIVE,
For primary bibliographic entry see Field 2E.
W84-01666

6G. Ecologic Impact Of Water Development

DISTRIBUTION OF LARVAL FISHES RELATED TO POTENTIAL NAVIGATION IMPACTS ON THE UPPER MISSISSIPPI RIVER, POOL 7,
National Fishery Research Lab., La Crosse, WI.
L. E. Holland, and J. R. Sylvester.
Transactions of the American Fisheries Society, Vol. 112, No. 2B, p 293-301, March, 1983. 5 Fig, 2 Tab, 13 Ref.

Descriptors: *Navigation, *Environmental effects, *Mississippi Rivers, *Fish, Larvae, Plankton, Diel distribution, Spatial distribution, Seasonal variation, Bass, Perch, Crappie, Drum, Shad, Carp, Channels, Boats.

Ichthyoplankton samples were collected twice monthly during spring and summer 1981 from a variety of habitats in Navigation Pool 7 of the upper Mississippi River. Larval-fish distributions in the pool and variations in those distributions were analyzed relative to potential impacts of increased commercial navigation. Although as many as 66 species of adults have been found in the area (33 considered common), only 17 taxa were identified from the collections. In April and May, most larvae were collected in main-channel and main-channel-border areas next to major expanses of shallow backwaters. White bass Morone chrysops, yellow perch Perca flavescens, and crappies Pomoxis spp. were predominant. Numerous catostomids also were taken. In June and July, most larvae were taken in the lower pool. Freshwater drum Aplodinotus grunniens and gizzard shad Dorosoma cepedianum predominated in these samples, which also included many cyprinids and centrarchids. Diel patterns of abundance varied with species and sampling location. Freshwater drums were more abundant near the surface at midnight than during the day. Common carp Cyprinus carpio were most abundant in collections at dusk, whereas all other cyprinids were most abundant at dusk and dawn. Numbers of gizzard shad also increased slightly at dusk. Total numbers of larvae collected were greatest at dusk in main-channel and main-channel-border samples; backwater areas produced the greatest catches at midnight and dawn. Seasonal, spatial, diel, and species-specific variations in larval fish abundances significantly influenced the proportion of the community potentially vulnerable to increased boat traffic through Pool 7. (Author's abstract)
W84-01408

HABITAT SELECTION IN THREE SPECIES OF DARTERS,
Saint Louis Univ., MO. Dept. of Biology.
F.H. McCormick, and N. Aspinwall.
Environmental Biology and Fishing, Vol. 8, No. 3/4, p 279-282, 1983. 3 Tab, 16 Ref.

Descriptors: *Fish, *Habitats, *Behavior, *Distribution, Vegetation, Etheostoma, Meramec River, Missouri, Percidae, Substrates.

The distribution of three species of darters (Percidae) was studied with respect to vegetation and substrate preferences. The three species were greenside darter, Missouri saddled darter, and banded darter. The study was made in the Meramec River drainage, Missouri. Based on pooled field data from five collecting sites, Etheostoma blennioides and E. zonale showed a highly significant distribution with respect to vegetation. E. tetrazonum, in contrast, was associated with substrate and Etheostoma blennioides and E. zonale demonstrated a significant preference for vegetation in olfactory gradient choice chamber experiments. In preference tests in the artificial stream, E. blennioides and E. zonale showed preference for natural vegetation versus substrate. In trials where the fish were presented with alternating patches of natural and artificial vegetation, post hoc comparisons revealed a significant preference for natural vegetation over artificial vegetation and substrate. (Baker-IVI)
W84-01448

MODELING OF UNSTEADY-FLOW WATER TEMPERATURES,
Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W84-01540

REVERSING THE FLOW OF SOVIET RIVERS.
For primary bibliographic entry see Field 3B.
W84-01622

THE TUCURUI EXPERIENCE,
Centre International de Recherches sur l'Environnement et le Developpement, Paris (France).
E. Monosowski.
International Water Power and Dam Construction, Vol. 35, No. 7, p 11-14, July, 1983. 2 Fig, 7 Ref.

Descriptors: *Dam construction, *Reservoirs, Brazil, Tucurui Reservoir, Powerplants, Water resources development, Environmental effects.

The largest man-made lake in Brazil, and the largest to be constructed in a tropical rainforest is scheduled to be filled next year. Tucurui dam is located 300 km south of Belem, the main city of the Eastern Amazon, and the dam will create a 2160 sq km reservoir, flooding the forest and backing up water for 200 km along the Tocantins river. The accumulation of 4,300,000 cu m of water will generate 2115 MW in the first stage, and the final installed capacity will be 800 MW. While the Tucurui scheme will be beneficial for the economic development of the whole Amazon area, its environmental impacts could endanger the very existence of the project. The Amazonian ecosystems are very complex, diverse and almost unknown. Decomposition of an enormous volume of vegetation in the flooded area will impair the water quality, thereby reducing oxygen availability and affecting aquatic organisms. The retention time, the depth and the temperature of the water and its speed of circulation appear to favor oxygenation in Tucurui allowing a rapid aerobic decomposition of most of the forest. While some flora and fauna will be destroyed, the dendritic-reticulate configuration of the reservoir will be an ideal habitat for waterweeds, with the accompanying problems. While dams will have an improving effect on the quality of life in distant communities, the lives of those in the immediate area will not likely be improved. (Baker-IVI)
W84-01627

THE STORM OVER SILENT VALLEY.
International Water Power and Dam Construction, Vol. 35, No. 7, p 14-17, July, 1983. 3 Fig.

Descriptors: *Environmental effects, *Water resources development, Decision making, Dam construction, Powerplants, India, Silent Valley, Kerala State.

Silent Valley is a small and until recently unknown strip of dense forest in Kerala state, at the southernmost tip of India. The valley occupies 8952 ha of what may be loosely described as tropical rain forest. It lies on a plateau perched on the western ghats, a range of mountains which borders the 1000 mile long coast of peninsular India. The area has an average annual rainfall of 4600 mm over a catchment of 77 sp km and the Kunthi is expected to yield an annual run-off of 293,000,000 cu m. The river offers a straight head of 857 m, the highest in Kerala. Silent Valley project envisages the construction of a rolled concrete arch dam, 131 m high and 430 m long; the creation of a reservoir submerging 830 ha and impounding 317,000,000 cu m of water; a water conductor system comprising a 4267 m long power tunnel, 260 m long pressure pipeline and a 2355 m long penstock branching into two near the powerhouse; and a power station on a small stream joining the Kunthi at the foot of the hills, 8 km from Mannarghat. Environmentalists are urging that the project be abandoned and the area declared a Biosphere Reserve. It is the last vestige of a natural climax vegetation of the region, and species in Silent Valley may have tremendous commercial potential. If the scheme is abandoned the benefits that will not be realized include: generation of 538 GWh of energy a year, expected to yield $10 million from sales of power and an increase in the GDP of $60-$100 million annually; irrigation of 10,000 ha in Palghat and Malappuram districts from the tailwaters; and the development of the most backward region of the state - the northern region of Malabar, where the project is to be situated. (Baker-IVI)
W84-01628

WATER RESOURCE AND THE ENVIRONMENT: DEVELOPMENT PLANNING IN BRAZIL,
Brazilian National Committee on Large Dams, Sao Paulo.
F. M. G. Budweg.

International Water Power and Dam Construction, Vol. 35, No. 7, p 23-24, 29-30, July, 1983. 1 Fig, 4 Ref.

Descriptors: *Dam construction, *Planning, *Environmental effects, Decision making, Water resources development, Powerplants, Brazil.

Planning procedures are being devised in Brazil that aim at the optimization of the multipurpose use of dams and reservoirs and the conservation of their environment. More than 90% of the electrical energy consumed throughout the country is hydropower. After World War II the country experienced an initially modest, but quickly progressing development of industrial activities. Parallel with it came an upswing in agricultural production that favored the spread of farming westwards into the country's interior. New hydroplants with ever larger dams and reservoirs began to be constructed in regions further away from consumption centers. Several hundred dams for water storage and irrigation have been built in the semi-arid northeast region since the turn of the century. Major efforts are being concentrated on flow regulation projects that will serve the double purpose of avoiding floods by the large-scale storage of excess runoff and the transformation of intermittent into perennial rivers by the controlled release of stored water for irrigation of large tracts of new farmland. Planning now revolves around multiple purpose projects. Reservoirs should be built after determining the best possible use of the water body created, thus reducing the number of specific projects to a minimum and obtaining the maximum advantage from each of them; and secondly, the reservoir plans should cover the mitigation of the unavoidable impacts on the natural and social environment. Integrated reservoir development results in many cases, in the need for some immediate expenditure in addition to that which would be incurred if the project were devised for its original purpose only. However, in the long run integrated reservoir development is undoubtedly the most economical solution. (Baker-IVI)
W84-01629

IMPACT STUDIES FOR DAMS AND RESERVOIRS,
Oklahoma Univ., Norman.
L. W. Canter.
International Water Power and Dam Construction, Vol. 35, No. 7, p 18-23, July, 1983. 1 Fig, 3 Tab.

Descriptors: *Environmental effects, *Dam construction, *Reservoirs, *Planning, Water quality, Water resources development, Environmental impact statement, Regulations.

Construction and operation of large dams and hydroelectric projects can cause significant environmental impacts. Systematic environmental impact studies are needed to predict and assess these impacts and identify appropriate mitigation measures. Impact predictions can be made using a qualitative approach which relies on general knowledge of the impacts of similar projects, or specific results of comprehensive studies of similar projects or on a quantitative approach based on the use of mathematical models for multiple environmental factors. A given environmental impact study will probably involve all these approaches. Impact assessment includes the use of water quality standards and criteria, appropriate laws and regulations related to the biological environment, and professional knowledge and judgement. Systematic methods are also available for comparing alternatives for large dams and hydroelectric projects. Assessment or interpretation of predicted impacts represents a vital activity in an environmental impact study. Decisions based on this activity include whether or not to approve a proposed project, and whether or not to prepare an environmental impact statement. Additionally the study will identify ways in which impacts can be mitigated and decide if these measures are necessary. Environmental impact studies typically consider a minimum of two options, but can include a study of 50 or more. The minimum number is a choice between construction and operation of a project and project non-approval. As more possible choices are included it becomes more and more necessary for a systematic environmental impact study to incorporate methodologies for trade-off analyses and decision-making between different choices. (Baker-IVI)
W84-01630

DEGRADATION OF THE RIVER NILE,
Research Inst. of Saad El Aali Side Effects, Cairo (Egypt).
S. Shalash.
International Water Power and Dam Construction, Vol. 35, No. 7, p 37-43, July, 1983. 7 Fig, 11 Tab.

Descriptors: *Environmental effects, *Water resources development, *Dam construction, Egypt, High Aswan Dam, Nile River, River beds, Sedimentation, Reservoirs.

One of the major tasks of the Research Institute of Saad El Aali Side Effects is to monitor the annual effects of degradation on the Nile River channel, particularly downstream of the existing hydraulic structures, occurring as a result of the construction of the High Aswan Dam in Egypt. The reach of the river currently under study starts from downstream of the low Aswan dam and ends upstream of the Delta barrage, a length of 953 km. There are five main control structures, each of which was built to a hydraulic design which did not affect the hydrological regime of the river before the construction of the High Aswan dam. Main hydrological parameters were recorded during the collecting of field data: suspended load measurements; water level records; discharge measurements and hydrographic survies. Downstream of Low Aswan, the drop in water levels varies between 42 and 40 cm for discharges of 10,000,000 cu m/day and 25,000,000 cu m/day, respectively. This is the total drop in water during the period 1964-1982. Downstream of Esna barrage the total drop in water level varies between 72 cm and 15 cm for discharges of 100,000,000 cu m/day and 200,000,000 cu m/day. For discharges of 80,000,000 cu m/day the drop in water levels was 76 cm for discharges of 80,000,000 cu m/day during the same period. Downstream of Naga Hammadi barrage the total drop in water levels is between 65 cm and 99 cm for discharges of 200,000,000 cu m/day and 800,000,000 cu m/day during the same period. Downstream of Asiut barrage the total drop in water levels are recorded as 49 cm and 78 cm for discharges of 150,000,000 cu m/day and 80,000,000 cu m/day during the same period. (Baker-IVI)
W84-01631

MALAYSIA ABANDONS TEMBELING,
Malaya Univ., Kuala Lumpur (Malaysia). Dept. of Geography.
S. S. Rachagan.
International Water Power and Dam Construction, Vol. 35, No. 7, p 43-47, July, 1983. 3 Fig, 6 Ref.

Descriptors: *Dam construction, *Environmental effects, *Water resources development, Planning, Reservoirs, Tembeling, Powerplants, Malaysia, Taman Negara, Public opinion.

A proposal to build a dam in Taman Negara for the Tembeling hydroelectric project was first brought forward in October 1971. The Sungai Tembeling is an upper tributary of Peninsula Malaysia's longest river, the Sungai Pahang. The need for flood mitigation and the hydroelectric power potential of the basin were the principal considerations for the dam. The project would have consisted of a main dam, saddle dams and associated works, including an intake feeding through a power tunnel to a conventional surface power station. With a total installed capacity of 110 MW comprising four units of 27.5 MW each, the average annual output of energy would be 441 GWh. A gated shaft spillway was planned with a capacity of 4800 cu m/sec for regulating flood discharges. Ecologists argued that flooding of such a large area could not be undertaken without societal consensus as to whether a large dam in this specific area was needed and sound as part of the nation's energy scheme. The key issue was that this area which had been proposed for the development of the dam and support structures was located in Malaysia's first and largest national park, a matter of great importance to the public. After 12 years of talking, researching, and considering alternatives, it appears that the environmentalists have convinced the Malaysian government of the need to abandon the proposed project. (Baker-IVI)
W84-01632

DEGRADATION OF THE RIVER NILE,
Research Inst. of Saad El Aali Side Effects, Cairo (Egypt).
S. Shalash.
International Water Power and Dam Construction, Vol. 35, No. 8, p 56-58, August, 1983. 7 Fig, 2 Tab.

Descriptors: *Environmental effects, *Dam construction, *Water resources development, Dams, Nile River, Egypt, High Aswan Dam, Deltas, Water levels, Discharges.

In order to monitor in the future the annual rate of change in the surface water slope of the Nile, the following methods were adopted to ensure good basic data for comparison. Water level gauges were selected at the beginning and end of reaches affected by degradation downstream of the hydraulic structures. Mean annual discharges downstream of each barrage, and water levels for the period 1963-1982 were measured. A relationship between the mean discharges and mean slopes for each reach are shown for the period 1963-1980. To calculate the slopes which correspond to the discharges before construction of the Aswan High dam, the same method was used. From the change in surface water slopes during the period 1963-1982, the maximum drop downstream of each structure was as follows: Low Aswan dam = 89 cm; Esna barrage = 65 cm; N. Hammadi barrage = 104 cm; and Asiut barrage = 96 cm. Eighteen years have elapsed since the High Aswan dam began to have an effect on the hydrological regime of the river Nile. The findings suggest a large difference between some of the theoretical forecasting and the actual results as regards the rate, maximum magnitude and time taken for the complete degradation process. (Baker-IVI)
W84-01638

THE JONGLEI CANAL: A DITCH TOO BIG,
R. Eshman.
Environment, Vol. 25, No. 5, p 15-20, June, 1983. 4 Fig, 40 Ref.

Descriptors: *Water resources development *Environmental effects, *Canals, Jonglei Canal, Egypt, Sudan, Nile, Drainage, Swamps, Hydrology.

The Jonglei Canal will run from Bor to Malakal in the southeastern district of Jonglei, Sudan when completed. It is not known how diverting water from the swamp ecosystem will affect the land, the indigenous people, and the hundreds of species of exotic wildlife in the Sudd. The purpose of the canal is to allow Egypt and Sudan to place 400,000 acres under irrigated cultivation and 4 million more when the canal is enlarged as planned. A total of 4.7 billion cu m of water will be diverted each year from the Sudd to irrigation projects downstream. The canal will also provide a time-saving transportation route from north to south. To achieve these ends no more than 19% of the Sudd will be drained. Critics of the canal foresee a possible breakdown in swamp ecology leading to up to 100% loss of these vital lands. A mathematical study has been made of the Nile hydrology. The Sudd's water table is replenished through the adsorption of water overspilling the river banks of the Nile in flood season. Reducing the amount of this overspill, which the Jonglei certainly would do, would affect the water table, possibly lowering it to such a degree as to affect the lives and environment of people far removed from the actual canal. A model was completed which assesses the amounts of inflow, outflow, seepage, and evaporation in the Nile region. (Baker-IVI)
W84-01727

SCHISTOSOMIASIS AND WATER PROJECTS: BREAKING THE LINK,
J. B. Tucker.

Environment, Vol. 25, No. 7, p 17-20, September, 1983. 2 Fig, 15 Ref.

Descriptors: *Human diseases, *Parasites, *Water resources development, *Environmental effects, *Schistosomiasis, Pathology, Diseases, Public health, Irrigation, Vectors, Drainage, Water management.

Schistosomiasis, after malaria, is now the world's most widespread, serious infectious disease. Many water resource development projects in tropical areas have had the unintended consequence of markedly increasing the prevalence of schistosomiasis in the local population. Water contact is the most critical variable in the transmission of schistosomiasis. Irrigation of formerly arid regions creates additional habitats for the snail vectors beyond those already present in ponds in rivers. Defects in the design or engineering of water projects may also provide new habitats for the snail hosts. The water projects have provided new opportunities for villagers to come into contact with the infested water, particularly when the projects are located close to villages in which no alternative water sources are available. The advent of perennial irrigation, in which the irrigation canals are is use year-round, has facilitated the multiplication of the snail vectors of schistosomiasis. Perennial irrigation has removed natural checks on the snail population enabling them to multiply out of control. Once snails have been introduced into an irrigation system it is impossible to eradicate them completely. If irrigation projects are supplied with efficient drainage, good water management and regular maintenance, it is possible to avoid an increase in the incidence of schistosomiasis. (Baker-IVI)
W84-01728

7. RESOURCES DATA

7B. Data Acquisition

COMPARISON OF TWO ICHTHYOPLANKTON SAMPLING GEARS WITH NOTES ON MICRODISTRIBUTION OF FISH LARVAE IN A LARGE RIVER,
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
R. P. Gallagher, and J. V. Conner.
Transactions of the American Fisheries Society, Vol. 112, No. 2B, p 280-285, March, 1983. 1 Fig, 5 Tab, 19 Ref.

Descriptors: *Fish, *Plankton, *Sampling, Biological samples, Larvae, Shad, Drum, Spatial distribution, Mississippi River.

A pilot comparison of two ichthyoplankton sampling gears was conducted in the lower Mississippi River, Louisiana. The two gears were (1) a 1-m-diameter conical plankton net towed at the surface and (2) two 0.5-m-diameter, bridleless, conical nets pushed at the surface from either side of the bow of a boat. Sampling was conducted on two different days, during light and dark periods, at three stations representing swift surface currents, sluggish currents, and slack water. Ichthyoplankton were more abundant in townet collections at the fastwater station during daylight hours and at the slackwater station at night, whereas pushed nets were more effective at the slackwater station during daylight hours and at the fastwater station at night. Shads Dorosoma spp. and freshwater drum Aplodinotus grunniens accounted for 94% of all fish larvae collected. Relative abundance of shads was greatest in daylight pushnet collections whereas drum were most abundant in daylight townet collections. Major additional trends: (1) shads, particularly protolarvae, were concentrated in the upper 50 cm of the water column in daylight collections, but were more uniformly distributed at night; (2) freshwater drums were more abundant in the 50-100-cm stratum during daylight collections, but were more uniformly distributed at night; (3) older freshwater drum larvae were more abundant in nighttime collections, whereas protolarvae were more abundant in daylight samples. (Author's abstract)
W84-01406

A SIMPLE TOXICITY APPARATUS FOR CONTINUOUS FLOW WITH SMALL VOLUMES: DEMONSTRATION WITH MYSIDS AND NAPHTHALENE,
Lehigh Univ., Bethlehem, PA. Dept. of Biology.
R. L. Smith, and B. R. Hargreaves.
Bulletin of Environmental Contamination and Toxicology, Vol. 30, No. 1, p 406-412, April, 1983. 2 Fig, 20 Ref.

Descriptors: *Continuous flow, *Toxicity, *Invertebrates, Measuring instruments, Naphthalene, Mysids, Crustaceans.

To determine the toxicity of naphthalene to the mysid crustacean Neomysis americana, a small continuous flow toxicant exposure system using design features of Mariotte bottle chemostats was built. The Mariotte bottles were modified by the addition of air inlet restrictors, providing a stable flow at low pressure heads. Solutions of naphthalene in artificial seawater were prepared with 0.5% naphthalene in 80% ethanol and placed in one-liter bottles. Rate of naphthalene loss from the reservoirs was determined by continuously measuring naphthalene concentration from a reservoir for 77 hr. Flow remained constant within 1.3% for 53 hrs regardless of volume remaining in the reservoir. There was a slight tendency for newly introduced water to stratify at the bottom of the chamber. Naphthalene disappearance probably resulted from evaporation into the reservoir head space, which could be reduced in the future by passing intake air through a bottle containing naphthalene test solution before introducing it into the reservoir. Estimated continuous-flow 96 LC50s were 1280 micrograms/liter at 15 C and 850 micrograms/liter at 25 C. Naphthalene-induced mortality was significantly greater at 25 C than at 15 C for both concentrations. Low flow allowed use of artificial seawater in small amounts, making it possible to perform tests at an inland location with standard dilution water. (Baker-IVI)
W84-01424

DATA AUTOMATION FOR WATER SUPPLY MANAGEMENT,
Idaho Dept. of Water Resources, Boise.
R. J. Sutter, R. D. Carlson, and D. Lute.
Journal of Water Resources Planning and Management, Vol. 109, No. 3, p 237-252, July, 1983. 6 Fig, 7 Tab.

Descriptors: *Automation, *Water management, *Computers, *Reservoir management, Data acquisition, Data transmission, Data processing, Streamflow, Water storage, Water allocation, Water rights, Water conservation, Snake River, Idaho.

The available daily water supply of multi-reservoir river system, the Upper Snake River in Idaho, is managed more efficiently using an automated system of data collection, transmission, and processing. Streamflow, reservoir, and canal data are transmitted daily from remote gage sites and regional terminals to a central computer where a FORTRAN program computes natural (unregulated) flow and accounts for storage water supplies. Natural flow is distributed among various uses (primarily irrigation) and users based on established water rights. Storage allocations are monitored daily to better manage remaining supplies. Daily uses and resulting supplies are projected ahead by as much as one week to reduce river operation response times. The improved management correctly accounts for water distribution by rights and for storage allocations while promoting conservation of water supplies. (Author's abstract)
W84-01464

FLOCCULATION TEST METHODS,
University Coll., London (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W84-01570

AN IN SITU SEDIMENT OXYGEN DEMAND SAMPLER,
Institute of Paper Chemistry, Appleton, WI.
B. E. Markert, M. G. Tesmer, and P. E. Parker.
Water Resources, Vol. 17, No. 6, p 603-605, June, 1983. 3 Fig, 9 Ref.

Descriptors: *Water analysis, *Sampling, *Oxygen demand, Sedimentation, Measuring instruments, Water sampling.

An SOD (sediment oxygen demand) sampler is illustrated which has a flow-through chamber with a pyramid top. The chamber is constructed of 1.25 cm clear Plexiglas material. It entraps 28.5 liters of water above 0.09 sq m of sediment, with a volume to area ratio of 0.3821 m. The second component of the sampler is the headbox unit, located in the boat and connected to the chamber by clear Tygon tubing. The design of the unit provides an easy mechanism for controlling the major factors which influence oxygen uptake by sediments. Low oxygen concentrations can be increased by purging air into the system, sediment disturbance can be observed visually, and water is circulated by a diffuser through the sampler to assimilate a lentic or lotic environment. In addition, toxicants can be injected to suppress biological activity and water samples can be removed during the run. (Baker-IVI)
W84-01675

8. ENGINEERING WORKS

8A. Structures

TECHNIQUE FOR CALIBRATING NETWORK MODELS,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
T. M. Walski.
Journal of Water Resources Planning and Management, Vol. 109, No. 4, p 360-372, October, 1983. 4 Fig, 4 Tab, 5 Ref.

Descriptors: *Water distribution, *Mathematical models, *Pipe roughness, Water use, Flow, Water pressure, Fire flow tests.

In calibrating a water distribution system model, the model user usually adjusts pipe roughness (e.g., Hazen-Williams C factor) or water use so that pressures and flows predicted by the model agree with values observed in the field. This paper presents formulas to assist the user in deciding whether to adjust C or water use and by how much. The key to using the formulas is to observe pressures in the system for at least two significantly different use rates. Such data are often collected during fire flow tests. A model is considered calibrated to the extent that it can predict the behavior of the water distribution system over a wide range of operating conditions and water use. (Author's abstract)
W84-01471

EXPERIMENTS TO ASSESS THE HYDRAULIC EFFICIENCY OF WELL SCREENS,
Water Research Centre, Marlow (England).
L. Clark, and P. A. Turner.
Ground Water, Vol. 21, No. 3, p 270-281, May-June, 1983. 13 Fig, 6 Tab, 15 Ref.

Descriptors: *Well screens, *Hydraulic properties, Head loss, Hydraulic efficiency, Gravel aquifers, Intake velocity.

The hydraulic properties of commercial well screens were investigated to determine which screen design features affected head loss. The test program began with laboratory experiments and continued as a field-scale experiment with the installation of a well field in the Thames Valley Gravel Aquifer. The laboratory experiments indicated that, for all practical purposes, the head loss attributable to all of the screens tested was negligible. The experimental head loss, however, did vary from screen to screen, particularly at high intake velocities, and the screens could be ranked on the basis of their hydraulic efficiencies. This efficiency hierarchy is explained tentatively in terms of the screen construction methods and slot geometry. The field experiments showed that the hydraulic performance of all well screens is independent of

screen design provided that the open area of the screen is above about 10%. The field experiments also indicated that the development capacity of a screen in a gravel aquifer is not wholly dependent on screen design, but that progressive development does increase the hydraulic efficiency of a well. (Author's abstract)
W84-01547

LARGE CAPACITY BULB UNITS IN JAPAN,
Fuji Electric Co. Ltd., Kawasaki (Japan). Hydro Power Div.
T. Ueda.
International Water Power and Dam Construction, Vol. 35, No. 3, p 19-24, March, 1983. 10 Fig, 2 Tab, 2 Ref.

Descriptors: *Turbines, *Hydroelectric plants, Akao power station, Japan, Generators, Sakuma power station, Bulb turbines, Shingo power station, Agano River, Low head.

Research into the economical development of small hydroplants has been carried out in Japan in efforts to increase the hydropower of that country. Three major factors were considered: high efficiency; minimum civil cost; and easy maintenance and high reliability. The Akao power station is a typical case in which an uneconomical low-head site became economically feasible through new technology. Its dam impounds 600,000 cu m net storage and was constructed on the Sho river to exploit the remaining 18 m effective head between two existing power stations at Narude and Ohara. The planned capacity was 32.5 MW, and a bulb turbine was chosen to give a low construction cost and to fit into a narrow powerhouse which was constricted by geographical limitations. The Sakuma 2 station was constructed to exploit a 15.5 m head which had been left unused between the existing Sakuma station (350 MW) and Akiba 2 station (34.9 MW). All the water discharged from the original Sakuma station is led to the opposite side of the Tenryu river through a reverse siphon-type water passage under the river to the headrace of the newly constructed Sakuma 2 station, through discharged to the Akiba regulating dam through a tunnel approximately 3.2 km long and 10.3 m in diameter. In still another location the Shingo 2 station was constructed at the opposite bank and in parallel with the existing Shingo station on the Agano River, which is one of the largest hydropower generating rivers in Japan. Shingo 2 was constructed to use the whole water flow and to balance the available water at each station. Using the existing dam of Shingo station, the No. 2 station was constructed with a maximum capacity of 38.8 MW at a maximum discharge of 200 cu m/s and maximum net head of 22.45 m. In all cases the technology of bulb turbines and generators was employed. It is assumed that in the future the unit capacity of bulb turbines and generators will be increased to 80 MW, with heads up to 25 m through further technological development. (Baker-IVI)
W84-01613

CONSTRUCTING THE DRAKENSBERG PRESSURE TUNNELS,
M. J. de Witt.
International Water Power and Dam Construction, Vol. 35, No. 6, p 13-22, June, 1983. 14 Fig, 1 Tab, 11 Ref.

Descriptors: *Tunnel construction, *Reinforced concrete, Construction, Tunnels, Concrete, Drakensberg, Pumped storage, Storage, Water supply development.

The power conduits for the Drakensberg pumped storage scheme traverse the Drakensberg escarpment over a distance of some 5 km with an elevation separation of 570 m. The interbedded sandstones, siltstones and mudstones, comprising the middle and lower Beaufort series rocks of the Karroo system in which the scheme has been constructed, exhibit very low primary and secondary permeabilities. Therefore, watertight linings were not required and unreinforced concrete linings were provided over much of the length of the low pressure conduits. Considerations related to hydrofracture of rocks, however, required a reappraisal of this approach in the high pressure waterways. Areal jacking, or uplift of the rock strata due to excess water pressure in zones of relatively low overburden stress, could not be tolerated, and the high pressure conduits through these areas were therefore provided with watertight steel linings. The final locations of the ends of the steel linings and the design of the associated cutoff arrangements were influenced by the proximity of faults. The design of the pressure tunnel linings in areas of adequate overburden stress was dictated by considerations of the durability of the rock traversed, the severe transient pressure fluctuations expected and hydro-fracture effects in the destressed rock close to the lining. The anticipated mechanism of hydrofracture and erosion dictated the design of the lower pressure shaft and pressure tunnel linings. Use of prestressed concrete linings, prestressed by interface grouting, ensured prevention of hydrofracture and erosion in the pressure tunnels and lower pressure shafts by providing a watertight lining which would ensure no hydraulic connection between the rock and the waterway, and by restressing the rock, forming a composite structure and full confinement of the rock. (Baker-IVI)
W84-01623

STEEL LININGS FOR HYDRO TUNNELS,
S. Jacobsen.
International Water Power and Dam Construction, Vol. 35, No. 6, p 23-25, April, 1983. 5 Fig, 1 Tab, 5 Ref.

Descriptors: *Tunnel linings, *Water supply development, Steel, Linings, Tunnels, Tunnel construction, Water transport, Mathematical studies.

The design of a ring stiffened lining that has been recently built is discussed to demonstrate how hazardous the design of such linings can be. In the steel linings considered, the original designer used specific Amstutz formulae. While it used to be the practice to carry out prestressing of steel linings by pressure grouting in old tunnels to prevent the water from infiltrating the lining and to increase the theoretical critical external pressure, this method is unreliable. The designer therefore assumed there would be a gap between the liner and the concrete originating from the inflating effect of the internal pressure during normal operation and the inability of rock and concrete to close the gap when the tunnel is being emptied or when the internal pressure is decreased. Since the distances from the neutral axis to the extreme outside and inside elements are so different, the maximum outside and inside stresses will also be different and it may be economical to use two grades of steel. In order to prevent buckling of the shell between the ring stiffeners, the stability of the shell must always be checked against the calculation of the critical external pressure for the ring system. Since the damage of the shell is less disastrous than the buckling of the rings, it may be reasonable to use lower safety factors for the shell than for the ring stiffeners. In designing the welds connecting the stiffener rings to the pipe shell the shear force is important. It is also advisable to calculate the stresses in the welding seam between ring and shell using the moment of inertia of the ring section and the total cross sectional area of the ring (including liner); to check the combined stress at the outer side of the shell at specified points; and to calculate the hoop stresses in the lining according to a particular method. (Baker-IVI)
W84-01624

THREE-DIMENSIONAL FINITE ELEMENT ANALYSIS OF THE LAPARAN DAM,
Bureau d'Ingenieurs-Conseils, Paris (France).
M. Hamon, P. Pouyet, and A. Carrere.
International Water Power and Dam Construction, Vol. 35, No. 8, p 19-24 and 29-30, August, 1983. 20 Fig, 15 Ref.

Descriptors: *Dam design, *Finite element method, Planning, Mathematical studies, Computers, France, Powerplants, Laparan Dam, Dams, Water resources development.

A comparison was made of the finite element analysis method specifically conceived for arch dams with the older trial load method, using the Laparan arch dam now being built in France. The thick-shell finite element analysis is a reliable and convenient tool for arch dam designers. At the design stage, in order to find the most efficient shapes for the structure, a relatively coarse mesh offers a satisfactory degree of accuracy in calculating stresses for quick and relatively cheap tests of the successive modifications made to the first conceptual design. At the subsequent stage of design justification, any desired degree of precision can easily be obtained, with a finer sub-division if necessary. If the designer wishes to explore in more detail the discontinuity where the dam meets the foundation and where the highest stresses usually occur, he can use the COBEF 3 program using block elements, with and without tensile stresses. It may be better to keep this type of analysis for special cases as, in a properly designed dam, the release of the tensile stresses that are almost inevitable at the heel, leads to an insignificant redistribution of the stresses in the dam and only slight changes in the existing compressive stresses. The programs COQEF 3 for thick shell analysis, and COBEF 3 with or without NOTEN 3 for no-tension conditions, can be considered as links in a chain of mutually compatible analyses for reliable and detailed exploration of an arch dam design. (Baker-IVI)
W84-01633

TUNISIA'S BOURGUIBA DAM AIDS REGIONAL DEVELOPMENT.
For primary bibliographic entry see Field 4A.
W84-01634

THIN ARCH DAM RESISTS ICE AND FLOODS,
Ministry of Water Conservancy and Power, Changchun (China).
W. Cai.
International Water Power and Dam Construction, Vol. 35, No. 8, p 37-39, August, 1983. 4 Fig.

Descriptors: *Arch dams, *Construction, Weathering, Floods, Ice, Dam construction, Water resources development.

Menkanshao power station on the Pushi River in the province of Lianoning consists of a thin arch dam, a tunnel, two penstocks, and a powerhouse. The catchment area is 198 sq km and the mean annual flow is 4.1 cu m/sec. The spillway design flood is estimated to be 1690 cu m/sec. The dam has withstood the sustained attacks of two floods larger than the spillway design flood and the extreme loading condition of ice thrust and freezing. The good performance of the dam is attributed to the reinforcement of the dam cylinder, particularly the heavier cantilever reinforcement. The principle of reinforcement is based on the assumption that stress in the arch direction is compression and the curved arch is flexible, while the cantilever, although free on the sliding joint, does experience moments in the lower part as a result of friction. Also moments may be produced because of uneven deformation and temperature variation. Since the cantilever is straight and shorter than the arch, it is stiller than the arch. Thus, considerable tension exists as indicated by computation. This is the reason why heavier reinforcement is placed in the cantilever direction. To improve performance in severe weather conditions, it is better to increase the cantilever reinforcement to about 0.1% of the cantilever section area, and the downstream face should be protected by an insulation layer. Also, it would be helpful to use electrical resistance wire buried in the sliding joint, to heat the joint and prevent it from freezing. (Baker-IVI)
W84-01636

FOR A RELIABLE WATER SUPPLY, COST COMES SECOND.
For primary bibliographic entry see Field 4A.
W84-01668

Field 8—ENGINEERING WORKS

Group 8A—Structures

EXISTING SCHEMES FOR CONSTRUCTING HIGH CONCRETE DAMS AND WAYS TO IMPROVE THEM,
V. I. Teleshev, and V. K. Loshak.
Hydrotechnical Construction, Vol. 16, No. 10, p 527-533, October, 1982. 3 Fig, 3 Tab, 7 Ref. Translated from Gidroteckhnicheskoe Stroitel'stvo, No. 10, p 6-11, October, 1982.

Descriptors: *Dam construction, *Concrete, Concrete dams, High dams, Design criteria, Construction, Hydroelectric plants, USSR.

To fulfill the indicated needs and accelerate construction of large hydrostations with concrete dams, at the current stage of development of hydrotechnical construction in the USSR it is necessary to increase the rate of placing concrete to 2 million cu m/yr with consideration of the fact that hydrostations are being constructed in narrow sites with a markedly confined field of operations. This requires the development and introduction of new concreting technologies, further improvement of concrete-placing operations, including preparation of the block for concreting and the preparation, transportation, and placement of the concrete mix with appropriate mechanization of all types of operations, including within the block. There are ways to improve each of the existing methods of delivering concrete to the block. The most promising of these are the craneless layer-by-layer, cableway, and crane trestleless (stepwise) methods. (Baker-IVI)
W84-01737

ADVANCED ENGINEERING IN THE DESIGN AND CONSTRUCTION OF THE CHIRKEY HYDROELECTRIC STATION,
M. A. Mironov, V. I. Grech, and N. I. Chalyi.
Hydrotechnical Construction, Vol. 17, No. 1, p 1-10, January, 1983. 6 Fig, 9 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, p 4-12, January, 1983.

Descriptors: *Construction, *Hydroelectric plants, Dam construction, Design criteria, Construction materials, Chirkey Hydroelectric Station, USSR.

The Chirkey hydrostation on the Sulak River in Dagestan ASSR is the most powerful hydrostation of the Sulak cascade and is intended to cover the peak-load part of the unified North Caucasian power system. The reservoir provided water for the development of irrigation agriculture on more than 300,000 ha, increased the water provision of water supply systems to a number of cities and towns, eliminated flooding of riparian lands in the lower reaches of the Sulak River and the need for annual reconstruction of protective embankments. A number of the engineering measures and technological methods successfully tested at Chirkey are presently being used elsewhere in the construction of large concrete dams and in the creation of turbine equipment for the powerful high-head turbines of the Nurek, Inguri, and Rogun hydrostations. In operation the Chirkey stations has an installed capacity of 1 million kW, possesses a 232.5 m high arch dam, and powerhouse with an original two-row arrangement of the units and has been proven to be a highly efficient structure. The developed and introduced layout design and industrial-technological measures made it possible to considerably reduce the amount of construction and installation works, to reduce the consumption of materials and cost of the structures, and to increase their reliability and operating qualities. The total saving from introducing just the main measures exceeded 20 million rubles. Among the most effective measures is the two-row layout of the units, the construction of a plug in the foundation of the arch dam with extension of the penstocks to the downstream face of the dam, the inclined intakes, and the new type of adjustable anchor support. The most important progressive industrial-technological measures are: the new technology of constructing concrete dams based on the use of cableways and a famiiy of mechanisms for intrablock mechanization as the general concrete-placing and installing means; use of cantilevel type formwork of a new type; suspension technology of installing the embedded parts of the turbine; and excavation of rock cuts by the smooth splitting method. (Baker-IVI)
W84-01751

EXPERIENCE IN THE DESIGN AND CONSTRUCTION OF THE SPILLWAY PART OF THE ZEYA DAM,
V. N. Vagner, and Ya. P. Mirzaev.
Hydrotechnical Construction, Vol. 17, No. 1, p 10-18, January, 1983. 7 Fig, 1 Tab, 1 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, p 12-26, January, 1983.

Descriptors: *Construction, *Spillways, Design criteria, Dam construction, Concrete, Dams, Zeya Dam, USSR.

The buttress dam of the Zeya hydroelectric station with a crest length of 714 m, height of 116 m, upstream slope of 1:0.15 and downstream slope of 1:0.8 consists of bank abutments with a total length of 390 m, a powerhouse part with a length of 144 m, and a spillway part 180 m long. The dam buttresses within the bank abutments and spillway part have a thickness of 7 m and in the powerhouse part below the intake sill, 5 m. The recesses between the buttresses are, respectively 8 and 7 m. The recesses are covered by reinforced concrete slabs on the downstream face. According to laboratory studies the specimens of cavitation-resistant concrete M 400, MRZ 400 containing Portland cement M 400 and gravel of the fraction up to 40 mm with the addition of GKZh-94 placed in the spillway part of the Zeya dam showed stable results of strength, frost resistance, and cavitation resistance meeting the design requirements. The OVG-50 formworks for concreting the slab and RS-50 framework for the dividing wall used for constructing the spillway part of the dam provide the evenness and smoothness required by the design, are rather simple to handle, and are recommended for use. With the exception of the central part, construction of the monolithic spillway bucket is possible in the OVG-50 formwork. The central part of the bucket is concreted with the use of precast reinforced beams or panel formwork. The formation of the curvilinear surface of the spillway bucket from precast reinforced concrete beams permits simplifying concreting of the bucket with the obtainment of a good quality of the concrete surface, but further design developments are needed for reducing the cost and metal consumption of the works. (Baker-IVI)
W84-01752

PILE SELECTION AND DESIGN: LOCK AND DAM NO. 26 (REPLACEMENT),
B. H. Moore.
Transportation Research Record, Vol. 884, p 45-49, 1982. 8 Fig, 9 Ref.

Descriptors: *Piles, *Locks, *Dam design, Soil mechanics, Load distribution, Navigation, Decision making, Mississippi River, Illinois, Alton, Lock and Dam No. 26.

Lock and Dam No. 26 is a major navigation structure on the Mississippi River at Alton, Illinois. At the site there is a large, unbalanced horizontal water load of 24 ft. The soils at the site are sands, gravels, cobbles, boulders, and clay tills that are 80 ft. thick. The history of, and logic for, the selection of piling on this project is presented. The soil and foundation information available at each stage of design is outlined. The initial capacities were determined through experience and application of remote testing. The final choice of pile design was experience-based but supplemented by extensive explorations and on-site driving tests. At Lock and Dam No. 26, both testing and conservative design were used in developing the current plans. An evaluation of pile test extent and timing by using decision-analysis techniques is recommended. Until the driving and testing of production piles are complete, conservatism must govern design thinking. (Moore-IVI)
W84-01760

8B. Hydraulics

SPACING OF WELLS FOR HEAT PUMPS,
Utah Water Research Lab., Logan.
C. G. Clyde, and G. V. Madabhushi.
Journal of Water Resources Planning and Management, Vol. 109, No. 3, p 203-212, July, 1983. 5 Fig, 3 Tab, 2 Ref.

Descriptors: *Well spacing, *Groundwater heat pumps, Breakthrough time, Groundwater movement, Anisotropy, Well yield, Water temperature, Injection wells, Production wells.

An approach to selecting the spacing of wells for ground-water heat pumps is developed. Breakthrough times for different well spacings are tabulated taking into account typical ground-water velocities, well flow rates, and flow directions. Typical sizes of residential lots are given. Tables are prepared to show ground-water temperatures at the producing well for different times after breakthrough. Adverse conditions to be expected during operation of the heat pump are described and some remedial measures are suggested. In most aquifers a spacing of 50 ft-75 ft (15.24 m-22.86 m) is satisfactory between the production and injection wells. The space between neighboring heat pump systems should be larger than the spacing between wells. In densely populated locations the available area may not provide for adequate spacing of wells. In such cases, the anisotrophy of most aquifers can be utilized to good advantage by pumping out from the top of the aquifer and reinjecting at the bottom of the same well. (Author's abstract)
W84-01462

OPEN CHANNEL HYDRAULICS OF FLOWS WITH INCREASING DISCHARGE,
Kuster und Hager A.G., Zurich (Switzerland).
W. H. Hager.
Journal of Hydraulic Research, Vol. 21, No. 3, p 177-193, 1983. 13 Fig, 2 Tab, 17 Ref.

Descriptors: *Channel flow, *Flow discharge, Hydrostatic pressure, Mathemetical models, Simulation, Subcritical flow, Supercritical flow, Channel inflow, Channel morphology, Hydraulic jump.

Based on a literature review, the most general equations are given for steady channel flows with increasing discharge; one-dimensional flow and hydrostatic pressure distribution are assumed. The prismatic, rectangular channel with arbitrary bottom slope and the non-prismatic, rectangular, nearly horizontal channel are investigated in detail. One-dimensional theory and hydrostatic pressure distribution allow relatively accurate simulation of the flow. Inaccuracies may occur at the beginning and at the end of the lateral inflow zone, mainly because of the discontinuous variation of the discharge. Transitions from subcritical to supercritical flow states are only formed in prismatic channels with relatively large bottom slopes. The state of flow never changes in all other channels except as discontinuity (hydraulic jump). (Moore-IVI)
W84-01485

EROSION NEAR GROYNE-LIKE STRUCTURES,
Alberta Univ., Edmonton. Dept. of Civil Engineering.
N. Rajaratnam, and B. A. Nwachukwu.
Journal of Hydraulic Research, Vol. 21, No. 4, p 277-287, 1983. 6 Fig, 1 Tab, 9 Ref.

Descriptors: *Groins, *Scour, Erosion, Flow control, Bed load, Hydraulic models, Model studies.

Erosion near the nose of the groin is a problem of considerable concern in cases where they have been used in rivers. Experiments on clear-water scour were conducted in a tilting rectangular flume, 120 ft long, 3 ft wide and 2.5 ft deep. The groin used was an aluminum plate 3 mm thick projecting perpendicularly from the side wall for a length of 6 in. A 9 in. thick sand bed was provided. In a typical test, uniform flow was first established without the groin and then the flow was stopped,

the groin was installed and the flow was reestablished. When the eroded bed profiles became approximately invariant, the profiles were used to prepare contour-type plots of the eroded bed. The maximum depth of erosion was found to occur near the nose of the groin. Based on this study, the growth of the maximum depth of scour with time has been found to be similar. Further, the characteristics of the scour hole in the end state have also been found to be similar. Some simple correlations have been developed for predicting the maximum depth of clear-water scour in the end state for a narrow range of the relative width parameter. (Moore-IVI)
W84-01486

PRESSURES ON SPILLWAY APRONS DOWNSTREAM FROM PARTLY RAISED CREST GATES,
Lavalin, Inc., Montreal (Quebec).
G. D. Ransford.
Journal of Hydraulic Research, Vol. 21, No. 4, p 303-314, 1983. 2 Fig, 3 Tab, 5 Ref.

Descriptors: *Spillway apron, *Negative pressure, Spillway gates, Cavitation, Mathemetical studies, Pressure, Spillways, Vena contracta.

An analytical study is made of pressures on a spillway apron downstream from a partly raised gate, and the results compared with experiment. A first step is to consider pressures produced by a thin nappe emerging on a parabolic (or trajectory type) apron from a gate without contraction, i.e. from a gate fitted with a hypothetical bellmouth type of inlet. This case can be analyzed exactly, using a power series development for the pressure as a function of time, or distance, after emergence. The result obtained consists of the product of two factors. The first is an expression, Y(1-Z/H) for the pressure on the sill immediately after emergence which, as to be expected, reduces to atmospheric should the operating head Z equal the design head H of the parabola, i.e. the head for which the jet follows the parabola exactly. The second factor represents the reduction in pressure with distance travelled after emergence. In the treatment of a thick jet Y(1-Z/H) has to be integrated over the height Y of the gate opening, or more accurately (with a contraction coefficient C), over height CY. By assuming a fixed center of curvature, a formula is derived for the pressure which is closely related to an earlier approximation suggested by Maitre. Comparison with experiment suggests that this approach is in fact inadequate, and has prompted the analysis of the change of curvature occurring at the location of the vena contracta, where surface curvature becomes nil momentarily. The formulae obtained on this basis, one with a linear reduction of curvature with height above the crest up to the surface at the vena contracta, and the other assuming a quadratic law of reduction, are shown to be satisfactory when compared with available data. A linear reduction of curvature with height appears to fit a parabolic spillway best, but, for a Creager or trajectory type, with sharper curvatures toward the summit, the second quadratic type formula appears more suitable. (Moore-IVI)
W84-01487

CHARACTERISTICS METHOD USING TIME-LINE INTERPOLATIONS,
Michigan Univ., Ann Arbor.
D. E. Goldberg, and E. B. Wylie.
Journal of Hydraulic Engineering, Vol. 109, No. 5, p 670-683, May, 1983. 11 Fig, 17 Ref. PFR 80-17429.

Descriptors: *Hydraulics, *Waves, *Method of characteristics, Mathematical models, Water hammer, Interpolation, Time-line interpolation.

The use of interpolations in time, rather than the more widely used spatial interpolations, demonstrates several benefits in the application of the method of characteristics to wave problems in hydraulics. Two such time-line schemes are presented and analyzed in the solution of a linearized water hammer problem. Reachback time-line interpolations, where the characteristic lines are projected back before the current time step, demonstrate less dampening than the correspondence spatial interpolation scheme at the same discretization. Implicit time-line interpolations, where the characteristic line is projected into the current time step, permit relaxation of the restrictive time step required by the Courant condition. An error analysis and numerical experiments demonstrate the degree of damping and dispersion introduced by both reachback and implicit time-line interpolation methods. The error analyses and their verification may encourage further application of these methods in appropriate problem domains. (Author's abstract)
W84-01541

INTERNAL FLOW IN HYDRAULIC JUMPS,
Windsor Univ. (Ontario). Dept. of Civil Engineering.
J. A. McCorquodale, and A. Khalifa.
Journal of Hydraulic Engineering, Vol. 109, No. 5, p 684-701, May, 1983. 11 Fig, 29 Ref.

Descriptors: *Hydraulic jump, *Stilling basins, *Internal flow, Mathematical models, Hydraulic models, Velocity, Shear, Centrifugal force, Turbulence pressure, Boundary layer, Entrained air.

Most stilling basins are designed on the basis of small scale model tests. The Froude Law is normally used for scaling the data; however, the relative effects of viscosity, entrained air, and entrance boundary layers are significantly different in the model and prototype. A mathematical model has been developed to help in the prediction of prototype performance from physical models. The technique used here is an extension of the strip integral method of R. Narayanan. The strip integral method uses velocity shape functions to permit the partial integration of the equations of motion. A Gaussian velocity distribution is used in the mixing zone and the power law is used in the inner layer. The mathematical model includes the bed shear, turbulent shear, the potential core, entrained air, centrifugal force and turbulence pressure. The model gives a fairly good prediction of the jump length, roller length, velocity distribution, water surface and pressure at the bed. The prediction of the growth of the boundary layer was not very good. The model indicated that the main effect of entrained air is the bulking of flow. The effects of centrifugal forces and turbulence pressures start to become significant for initial Froude numbers greater than 5. (Moore-IVI)
W84-01542

APPLICABILITY OF DAM-BREAK FLOOD WAVE MODELS,
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
N. D. Katopodes, and D. R. Schamber.
Journal of Hydraulic Engineering, Vol. 109, No. 5, p 702-721, May, 1983. 9 Fig, 18 Ref.

Descriptors: *Flood waves, *Flood routing, Mathematical models, Open channel flow, Kinematic waves, Dam failure, Flood depth.

Mathematical models based on the Saint-Venant equations for open channel flow often encounter serious difficulties when applied to natural channels. On the other hand, the approximate flood routing models used in practice may yield results which are in gross error. In this work five mathematical models are constructed based on equations ranging from the complete dynamic system to a simple normal-depth kinematic wave equation. The results of the models are compared between themselves and with experimental data, in the form of free-surface profiles and stage hydrographs. The models are then converted to dimensionless form, which reduces the number of independent parameters controlling their solution. The results of these calculations are presented in the form of dimensionless plots of maximum flood depth and time vs. distance along the channel, for various levels of truncation of the open-channel flow equations. Estimates for the permissible range of application of the simplified routing models are given, and recommendations are made for their judicious application. (Author's abstract)
W84-01543

TURBULENT UNDERFLOW IN A SHORT CHANNEL OF LIMITED DEPTH,
University of Western Ontario, London. Faculty of Engineering Science.
R. E. Baddour, and H. Abbink.
Journal of Hydraulic Engineering, Vol. 109, No. 5, p 722-740, May, 1983. 13 Fig, 19 Ref.

Descriptors: *Underflow, *Channel flow, *Turbulence, Density stratification, Internal jump, Flow instability, Hydraulic models, Mathematical models, Mixing, Froude number.

The flow characteristics of a turbulent underflow in a horizontal channel of limited depth are explored analytically and experimentally under a variety of upstream and downstream control conditions. Freshwater and salt water are used in the physical model to simulate a stable density stratification, and a contraction is adopted as a downstream control device. Three typical flow situations, respectively, distinguished as drowned internal jump, free internal jump, and flow instability, are observed depending on the nature of the interaction between the upstream and downstream controls. The hydraulic properties of each one of the flow situations are reviewed, and the experimental observations are compared with the results obtained from a hydraulic analysis. Maximum turbulent mixing is demonstrated to occur at a particular value of the discharge densimetric Froude number. Further increase of discharge densimetric Froude number is expected to result in a decrease in turbulent mixing and eventually to provoke a flow instability. (Author's abstract)
W84-01544

CALCULATION OF A LOCAL SCOUR DEPRESSION NEAR A PROTECTED CONCAVE BANK OF A GRAVEL-PEBBLE CHANNEL,
V. A. Bazilevich.
Hydrotechnical Construction, Vol. 16, No. 10, p 547-554, October, 1982. 2 Fig, 1 Tab, 14 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 10, p 19-20, October, 1982.

Descriptors: *Channel scour, *Mathematical studies, Gravel, Pebbles, Depression, Scour, Abrasion, Erosion, Meanders.

A simplified calculation method was developed on the basis of analyzing the results of calculations by the complete method of the Institute of Fluid Mechanics to predict the depth of a scour depression at the toe of a protected concave bank of a meander in gravel-pebble channels and to determine the rate of this scouring. The main conditions making it possible to use the simplified calculation method are; disregard of the balance of the bed load, and the nonuniformity of the flow in the scour depression at the protected concave bank of meanders. To perform the calculation it is necessary to have the value of the average slope of the free surface of the water on the axis of the flow, which is assumed constant during deformation of the bottom of the meander. In the calculation one determines the vertically averaged velocity of the nonuniform flow and the friction velocity in the scour depression, which must be compared with the friction velocity corresponding to the detachment of the erosion pavement of inhomogeneous soil composing the bottom of the meander. To check whether the calculated deepening of the bottom can occur during the duration of the calculated flood on the basis of the value of the bed-load discharge, the rate of deepening of the bottom in the scour depression is determined with the use of a method provided. The reliability of the recommended simplified calculation method is confirmed by the results of comparing the calculated and experimental values. (Baker-IVI)
W84-01738

PRESSURE FLUCTUATIONS ON THE BOTTOM OF OPEN-CHANNEL TURBULENT FLOWS IN SPILLWAY STRUCTURES,
A. A. Ivoilov.
Hydrotechnical Construction, Vol. 16, No. 10, p 554-559, October, 1982. 3 Fig, 1 Tab, 10 Ref.

Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 10, p 23-25, October, 1982.

Descriptors: *Spillways, *Turbulence, *Hydraulic engineering, Construction, Pressure, Design criteria, Dam construction, Aeration.

Correct consideration of the hydrodynamic effect of a turbulent flow on elements of spillway structures is one of the important problems of modern hydraulic engineering. One characteristic of open-channel flows on high-head spillway structures is their severe aeration within the conveyance channel, and when the flow is ejected from the structure by means of a ski-jump bucket its considerable fragmentation during free fall is also noted. A theoretical analysis of the equations of hydrodynamics describing the motion of a water-air mixture shows that in this case, compared to the flow of a one-phase fluid, a number of additional factors have an effect, which can change the hydrodynamic characteristics of the flow. Pressure fluctuations on the bottom of the gradually varied and markedly nonuniform flow are reproduced sufficiently well on models of the structures, and the slight distortions of the energy-frequency spectrum caused by the nonmodelability of aeration and microturbulence of the flow can be disregarded. If it is necessary to conduct dynamic calculations of the structures, when a rigorous and spectrum-differentiated consideration of the pressure fluctuations is required, corrections obtained on the basis of the examined investigations can be introduced. The intensity of the pressure fluctuations on the bottom of the flow under the free-falling flow under prototype conditions compared to the model data noticeably decreases due to aeration and fragmentation of the flow, which for all practical purposes are not reproduced in the model. (Baker-IVI)
W84-01739

ON-SITE INVESTIGATIONS OF THE HYDRAULIC REGIMES OF A TRANSITION STRUCTURE,
P. V. Kutsenko, O. V. Kikish, and T. N. Rogovoi.
Hydrotechnical Construction, Vol. 16, No. 11, p 613-616, November, 1982. 1 Fig, 1 Tab, 7 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 11, p 27-29, November, 1982.

Descriptors: *Channels, *Powerplants, *Water levels, Hydraulic machinery, Construction, Design criteria.

The design and operation of transition structures on channels of thermal and nuclear power stations should provide reliable, accident free operation of these structures. To maintain the necessary water levels and to join the pools a transition structure made in the manner of a tower spillway was constructed on the discharge channel at the Zaporozh'e state regional electric power station. The transition structure represents two unregulated spillways in the form of an overflow reinforced-concrete wall with heights of 2.46 and 2.6 m, thickness of 0.6 m, and total length of the spillway face of 75 m. Investigations of the hydraulic operating regimes of the transition structure were carried out in the fall of 1979 and the spring of 1980. During the first stage the investigations were conducted at various discharges of water through the structure into the lower pool and at a water level in the lower pool of the structure of 18.00 m. During the second stage the investigations of the hydraulic operating regimes of the transition structure were carried out at a constant discharge of 103 cu m/sec through it and with the water level in the lower pool of the structure raised to 18.55 m. A vacuum is created in the initial section of the discharge pipes of the transition structure, which explains the entrapment of air with water in them. Air accumulates in the pipes owing to the Archimedean buoyant force directed opposite to the flow of the water. It is possible to provide discharges under acceptable conditions if a vacuum is absent at the inlet section of the pressure pipes. (Baker-IVI)
W84-01744

HYDRAULIC INVESTIGATIONS OF FLOOD PASSAGE OVER A FLOODPLAIN AROUND CHANNEL STRUCTURES,
D. V. Shterenlikht, and I. F. Pikalova.
Hydrotechnical Construction, Vol. 16, No. 11, p 616-622, November, 1982. 4 Fig, 10 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 11, p 29-32. November, 1982.

Descriptors: *Flood plains, *Channels, *Erosion, Hydraulics, Mathematical studies, Flood profiles, Construction, Design criteria.

Analytical and experimental investigations were conducted the movement of the flow over the floodplain around various types of channel structures. The experimental part of the work involved two flumes measuring 3.0 x 23.0 and 1.0 x 19.0 m in plan. The models were made of sand with concrete-crust coating and represented half of a parabolic channel with a rectangular floodplain adjacent to it. The experiments were conducted with three different values of the width of the floodplain and three values of its roughness coefficient. The floodplain did not have a transverse slope; the longitudinal slope of the floodplain and channel was 0.0012. Investigations of channel structures around which the flow passed were carried out at water discharges of low probability, when a single through-going flow is formed on the flood-plain and nonparallelism of the maximum velocity threads of the channel and floodplain flows is the least probable. The performance of nonoverflow guide groins on the floodplain was studied to create the most favorable conditions of streaming of the flow around the channel structures. Groins of an elliptical configuration shifted downstream relative to the site showed the best performance. Such an arrangement of the groins promoted a decrease of nonuniformity of the velocity distribution at the site of the structure and a decrease of maximum velocities in the immediate vicinity of the structure. (Baker-IVI)
W84-01745

HYDRAULIC LOADS ON THE SOLID BOUNDARY OF A FLOW UNDER THE EFFECT OF A FRAGMENTED JET,
L. D. Lentyaev, L. V. Smirnov, and A. G. Shubin.
Hydrotechnical Construction, Vol. 17, No. 1, p 28-31, January, 1983. 5 Fig, 6 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, p 22-24, January, 1983.

Descriptors: *Fluid mechanics, *Jets, Nozzles, Fragmented jet, Hydraulic loading, Energy.

One of the main advantages of the scheme of joining pools by deflecting the jet compared to the scheme of dissipating the energy of the flow in a hydraulic jump is the substantially smaller level of dynamic loads on revetment elements of the lower pool due to fragmentation of the flow in the bay. Earlier recommendations concerning the structure of loading a solid boundary of a flow by fragmented falling jets of water when joining pools with deflection of the jet are confirmed by direct measurements of the dynamic reactions and can be recommended to hydraulic engineers for use in design practice when calculating revetment elements of lower pools of hydraulic structures. A schematic diagram of the experiments performed is provided. The jet of water, formed by a nozzle having a 0.2 x 0.5 m rectangular section and 1:4 contraction coefficient, which was fastened on a pressure tank, was discharged into a 4-m side horizontal flume with vertical walls equipped with an end device regulating filling of the flume in limits from 0 to 1.5 m. The head above the center of the nozzle was 2.3 and 7.7 m, which corresponded to nozzle discharges of 0.670 and 1.225 cu m/sec. The vertical distance from the nozzle axis to the flume bottom was 7.9 m. A the sensor of the total load a small steel beam was used, rigidly fixed on one end and free on the other. The beam-sensor was installed under the center of fall of the jet, flush with the flume bottom. (Baker-IVI)
W84-01753

SMALL STREAM CHANNEL DAM AERATION CHARACTERISTICS,
Illinois State Water Survey, Peoria. Water Quality Section.
T. A. Butts, and R. L. Evans.
Journal of Environmental Enginering, Vol. 109, No. 3, p 555-573, June, 1983. 8 Fig, 8 Tab, 19 Ref.

Descriptors: *Weirs, *Spillways, *Aeration, Head loss, Mathematical models, Hydraulic jump, Dams, Illinois.

Field data were collected at 54 small stream head loss structures in northeastern Illinois to evaluate weir and spillway aeration characteristics. The British dam aeration equation, which employs the use of an aeration coefficient (b), is used as a model to calibrate each head loss structure. The head loss structures are categorized according to basic physical configurations; nine generalized classes are presented. The aeration coefficients vary widely within classes due to seemingly small or subtle differences in structural design or overall physical condition. Spillways having the same basic geometric design may exhibit widely divergent aeration coefficients depending upon conditions at the toe or apron. Hydraulic jumps built into toes produce significantly higher b-values than those similarly constructed but without hydraulic jumps. The nine dam categories are assigned aeration coefficients which represent the median value observed within each grouping. These values are suitable for use in preliminary model development or when time constraints preclude making field surveys. However, whenever possible field surveys should be conducted using the methodology presented as a guide. (Author's abstract)
W84-01768

8C. Hydraulic Machinery

OPTIMUM CAPACITY OF A RUN-OF-RIVER PLANT,
International Engineering Co., Inc., San Francisco, CA.
F. Fahlbusch.
International Water Power and Dam Construction, Vol. 35, No. 3, p 45-48, 3 Fig, Tab, 9 Ref.

Descriptors: *Capacity, *Decision making, *Dam construction, Mathematical studies, Powerplants.

A rigorous formulation and an analytical solution are presented to the problem of determining the optimum capacity of a run-of-river plant. Among the evaluation criteria available, a maximization of the net benefit is generally considered as the most appropriate one. The net benefit is described as the difference between total benefits and total cost and is expressed in average annual terms. A run-of-river plant may be viewed as a system which converts a stochastic input process, streamflow, into a stochastic output process, power. The approach does not suffer from usual shortcomings, but rather it shows that even an analytical solution of the exact formulation exists. The resulting capacity decision rule is simple to implement, and provides valuable guidance to judge the possible effect of imprecise cost and benefit data on the design capacity. The objective function has the typical structure of the objective functions describing single-period inventory decision problems under risk. The distinguishing characteristic of this kind of problem is that there is only one opportunity for procurement, scale or target decisions. The theory and results of this study may be applied to any hydro plant, with or without pondage, if the objective is maximum exploitation of energy and not the provision of peak capacity. (Baker-IVI)
W84-01616

FIRST PUMPED-STORAGE SCHEME FOR THE PHILLIPPINES,
National Power Corp., Manila (Philippines).
J. Polintan, and M. Pellaschiar.
International Water Power and Dam Construction, Vol. 35, No. 4, p 13-16, April, 1983. 4 Fig, 2 Tab.

Descriptors: *Dam construction, *Decision making, *Pumped storage, Powerplants, Hydroelectric plants, Phillipines, Kalayaan, Caliraya Lake.

Kalayaan is an exceptionally positive site for the installation of a pumped-storage plant as it is ideally located, being only 15 km away from a large thermal plant. Its proximity to Manila has been a major factor influencing the engineers concerned with the project. Caliraya Lake, the upper manmade reservoir, is connected to the Lumot reservoir. The combined normal active storage is about 30,100,000 cu m with the water level from a minimum elevation of 286 m to a maximum of 288 m. The major roles of the plant will be the transformation of base energy to peak energy, and to reduce the risk of the generating system of being unable to meet the demand. Other characteristics which may be important in the operation of the plant include: the possibility of following very fast load variations with a readiness unmatched by thermal peak generation facilities; the extremely short starting times; the possibility of passing rapidly from the pumping to the generating mode and vice versa with the effect of improving the system reliability in case of disturbances; and the possibility of operating as a synthronous condenser for the regulation of reactive power and voltage. Development of the project will be in the following stages: the upper canal, the intake, the penstock, the powerhouse, the buildings, the switchyard, the dock and the lower canal. (Baker-IVI)
W84-01617

THE WORLD'S HIGHEST HEAD PUMP TURBINES,
Toshiba, Yokohama (Japan). Hydraulic Machinery Group.
S. Tsunoda, K. Harada, and A. Yamakami.
International Water Power and Dam Construction, Vol. 35, No. 4, p 17-21, April, 1983. 9 Fig, 1 Tab, 4 Ref.

Descriptors: *Dam construction, *Pump turbines, Design criteria, Turbines, Engineering, Construction, Mechanical equipment, Chaira Dam, Bulgaria.

Four reversible pump-turbines have been manufactured for the Chaira scheme in Bulgaria which are the world's highest head single-stage machines. The single-stage reversible pump-turbines each have a rated output of 216 MW in the generating mode with a rated speed of 600 rev/min and a pumping head of 701 m. The upper reservoir in the system is created by the existing Belmeken dam with a usable storage capacity of 146,000,000 cu m, and the lower reservoir, by Chaira dam with an effective water storage of 3,500,000 cu m. The waterway consists of an underground system of tunnels, surge chambers, penstock and powerhouse caverns extending over a horizontal distance of about 5300 m from the upper reservoir to the lower reservoir. (Baker-IVI)
W84-01618

ADVANCES IN PUMP-TURBINES DESIGN,
Allis-Chalmers Corp., York, PA.
R. K. Fisher, and J. R. Degnan.
International Water Power and Dam Construction, Vol. 35, No. 4, p 21-26, April, 1983. 10 Fig, 1 Tab, 6 Ref.

Descriptors: *Design criteria, *Pump turbines, Dam construction, Computers, Turbines, Decision making, Hydraulic design.

The system and philosophy used to develop today's pump-turbine designs are reviewed. Design objectives are to produce equipment which has the characteristics of reliability, easy servicing, operational flexibility and high performance. The success of this approach is made possible by integrating design history and field experience into computer design and analysis systems. These systems use the latest analytical tools to provide a thorough understanding of hydraulic, mechanical and operational behavior. They are supplemented by a comprehensive set of statistics on existing units and their operating problems. Extensive testing of models and operating equipment provides further input for design optimization and the feedback needed to make further improvements. Hydraulic design improvements are pursued using a mean streamline performance prediction program to calculate both pump and turbine cycle performance as a function of wicket gate opening. Parametric studies of changes in water passage geometry are conducted and evaluated to maximize performance. Mechanical design refinements are studied using the finite element method. Two- and three-dimensional finite element method analyses are used to predict the static and dynamic structural response needed to achieve the desired reliability in the detailed mechanical design. An extensively correlated hydraulic transient program is used to evaluate and refine field behavior during the design process. Model test data, site water passageways, steady and dynamic loads and governor data are combined to predict machine behavior during start-up, load rejection, and operating mode change. Final refinements of operation are developed through comprehensive field tests during unit commissioning. (Baker-IVI)
W84-01619

MECHANICAL EQUIPMENT FOR DINORWIC.
International Water Power and Dam Construction, Vol. 35, No. 4, p 29-31, April, 1983. 3 Fig, 2 Tab.

Descriptors: *Mechanical equipment, *Fatigue, *Pumped storage, Dam construction, Storage, Turbines, Valves, Penstocks.

At the Dinorwic pumped storage station, equipment is designed to stabilize frequency variations; a machine may change from spinning to generation and back to spinning four or five times an hour. The design of the mechanical equipment such as pump turbines valves, and penstocks has been strongly influenced by the requirements to counter any problems of fatigue. A special program was developed for testing those components at risk, such as top and bottom covers of the pump-turbine spiral casings and elements of the main inlet valves. Components which were to be subjected to the fatigue inducing forces were examined ultrasonically, and the position and size of any imperfection were corrected. One unusual feature if the use of a Ringfeder locking assembly for the guidevane linkage. A simple arrangement of concentric tapered rings allows the guidevane link to slip at a predetermined torque higher than the normal operating value. Should material enter the water system and jam the guide vanes, the Ringfeder mechanism will prevent any of them from breaking loose from the assembly and causing damage to adjacent ones. Other components of the system that have unusual operating parameters are the main inlet valves which have to operate quickly and reliably, and if necessary, close without external power. (Baker-IVI)
W84-01620

OPTIMIZATION OF DREDGE AND VARIABLE DISPLACEMENT PUMPS,
P. R. Khlopenkov.
Hydrotechnical Construction, Vol. 16, No. 11, p 622-630, November, 1982. 6 Fig, 9 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 11, p 33-37, November, 1982.

Descriptors: *Pumps, *Mechanical equipment, *Water delivery, Operation wastes, Energy, Dredging, Centrifugal pumps.

Nonproductive expenditures of electric energy occur at pumping stations with variable operating regimes; with a decrease of water consumption the head increases, whereas the network resistance decreases. As a consequence, the head exceeds the required values by 10-40% for the greater part of the day. This leads not only to an overconsumption of energy but also worsens the operating conditions of the network. The optimal solution is regulation of the head and delivery by changing the dimensions of the main operating elements of the pump by gradual variation of the outlet diameter of the impeller, or gradual variation of the width of the passages in the impeller and discharge pipe, or simultaneously by changing in certain combinations both the outlet diameter of the impeller and width of the impeller passages and discharge pipe. Centrifugal pumps with an adjustable outlet diameter and width of the impeller passage and discharge pipe were shown to improve operation of a given network and made it possible to reduce energy expenditures at pumping stations by 10-20%. By obtaining clean water directly from sludge and directly in the pump without pressure losses, it was possible to solve the problem of protecting pump elements from abrasion by a wall boundary layer without increasing energy expenditures on injecting clean water into the internal cavity of the pump. By fractionation of sludge in pressure settling tanks, without pressure losses, it was possible to use inferior borrow pits near hydrotechnical construction sites for reducing transportation expenditures on delivering inert materials to the site. (Baker-IVI)
W84-01746

IMPROVEMENT OF THE MECHANICAL EQUIPMENT OF HIGH-HEAD SPILLWAYS,
M. F. Krasil'nikov.
Hydrotechnical Construction, Vol. 16, No. 12, p 644-652, December, 1982. 8 Fig, 4 Tab, 6 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 12, p 38-43, December, 1982.

Descriptors: *Spillways, *Mechanical equipment, *Gates, Construction, High pressure gates.

The problem of creating high-pressure gates for high-head powerstations has become acute in connection with expansion of the construction of hydrostations combining high heads with large waste discharges. Studies have been made in three principal directions to solve the problem: creation of reliable and effective designs of the main regulating and emergency guard gates for heads up to 200 m with an area of the opening being covered up to 60 sq m; creation of reliable and effective large-capacity lifting gear and with a large height of lifting the gates, supporting parts for large loads, and designs of gate seals with the use of new materials; the search for new layout designs of the surplusing works which effectively dissipate the excess kinetic energy of the high velocity flow beyond the main regulating gate to eliminate the destructive action of the flow on the structural part of the structure. The studies have demonstrated the real possibility and economic expediency of manufacturing mechanical equipment for regulating large waste discharges at a head of 200 m, and the effectiveness of using the effect of swirling of the discharging flow in spillway systems. Further perfection of the mechanical equipment of high-head spillways should improve the layouts, increase the precision and quality of manufacturing gates and drives, operating reliability of the seals, vibration resistance, and protection from cavitation. (Baker-IVI)
W84-01748

EVALUATION OF STRESSES IN ELEMENTS OF THE LOCK GATES ON THE MOSCOW CANAL,
V. G. Abrosimov, O. L. Bandin, A. P. Gusenkov, and V. P. Kogaev.
Hydrotechnical Construction, Vol. 16, No. 2, p 653-656, December, 1982. 3 Fig, 2 Tab, 5 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 12, p 43-45, December, 1982.

Descriptors: *Lock gates, *Stress, *Evaluation, *Canals, Moscow Canal, USSR, Gates, Mechanical equipment, Mechanical failure.

Experience gained in operating the mechanical equipment of the Moscow Canal and certain other transporting hydraulic structures indicates that the reliable operation of engineering works is to a considerable degree determined by the strength of lock gates. The main elements of the gates include the load-bearing space truss consisting of riveted and welded elements, support elements, retaining elements and watertight skin plates. Atter several years of operation, cracks were found in the weld zone of the gates near the attachment holes in the retaining elements, in the angle flanges of the lower tie beam, and in the skin plate. On the basis of analyzing the working conditions of the elements of the lock gates and on-site strain measurements, the low cycle character of loading and

the possibility of failure in the maximally stressed zones was confirmed to be a consequence of the occurrence of repeated elastoplastic deformations in the structural material. It is necessary to calculate and determine experimentally the low-cycle life of elements of the load-bearing structures of lock gates and to work out recommendations on increasing their resistance to cyclic failure. (Baker-IVI)
W84-01749

8D. Soil Mechanics

THE EXCAVATION OF LARGE UNDERGROUND OPENINGS: A NUMERICAL SIMULATION,
Istituto Sperimentale Modelli e Strutture SpA, Bergamo (Italy).
M. Borsetto, and A. Peano.
International Water Power and Dam Construction, Vol. 35, No. 6, p 28-33, June, 1983. 9 Fig, 1 Tab, 34 Ref.

Descriptors: *Excavations, *Model studies, *Mathematical models, Rock excavation, Powerplants, Rock mechanics, Rocks.

The relative merits of various mathematical models used in the computations for constructing eight underground stations owned by the Italian power authority are discussed. The first attempt to use finite element models was based on the assumption of elastic material behavior. In the case of Lake Delio power station the aim was to identify the original stress state by fitting extensometer readings made during the excavation of the opening. Discrepancies lead to the development of more refined mathematical models. Hence the material was assumed to be linearly elastic under compression only: tensile stresses were redistributed according to the iterative method developed by Zienkiewicz. A realistic material model of the rock mass calls for a Mohr-Coloumb failure criterion, a strain softening law and a tensile cut-off. This approach was implemented in the computer program NOLIPL based on the stress transfer technique. The availability of realistic material models makes it possible to interpret the deformational behavior of the rock mass at various excavation stages and therefore it provides an adequate check of the design assumptions. To monitor the deformation occurring in the rock mass various rock extensometers are usually installed. A good agreement between the observed and expected performance of the opening confirms the designer's safety assessment. Some important cost- and time-savings procedures include reducing the size of the discretization by the boundary elements technique or by modelling the boundary conditions using infinite-finite elements; minimizing the number of degrees of freedom by using accurate approximation techniques based on high order polynomials; and tuning the algorithm for the solution of the system of linear equations on the basis of the characteristics of the hardware system. Typical aspects include a reduction in the paging in virtual storage computers and optimization of vector operations. (Baker-IVI)
W84-01625

MATERIALS FOR HIGH EMBANKMENT DAMS,
Vsesoyuznyi Gidroproektno-Izyskatel'skii i Nauchno-Issledovatel'skii Inst. 'Gidroproekt', Moscow (USSR).
V. I. Vutsel, Yu. K. Zaretsky, E. I. Vorontsov, A. G. Chernilov, and B. D. Chumichev.
International Water Power and Dam Construction, Vol. 35, No. 8, p 33-37, August, 1983. 6 Fig, 4 Ref.

Descriptors: *Dam construction, *Construction materials, Embankments, Soil properties, Testing procedures, Tensile stress, Stress.

In designing embankment dams the following main calculations are necessary: determination of the seepage stability of the dam body, its foundations, the banks and slopes; calculation of the settlement of the dam body and foundation to determine the required freeboard and the value of differential settlement of its different elements; calculation of horizontal displacements of the dam elements. The analysis for high (over 70 m), rockfill dams, used to determine their rational designs, should incorporate a considerable range of variations of stresses acting in the dam body. The stress, strain and stability analyses of high rockfill dams should take into consideration the real non-linear stress-strain relations. Analyses of soil materials are performed with the help of computers using programs based on the deformation theory of plasticity or the theory of plastic flow, and taking into account the possible consolidation of the clayey soils in anti-seepage dam elements, and the technique, sequences and time schedule of the construction program. Initial soil placement parameters are usually determined by the standard compaction method, involving the tamping of soils with different moisture contents at the standard impact impulse and the compacting effort. Strength and deformability characteristics of materials for anti-seepage elements are determined using the triaxial apparatus for testing specimens 60 and 100 mm in diameter. For assignment of the soil density, the concept of the relative compaction is used. (Baker-IVI)
W84-01635

EVALUATION OF THE ACCURACY OF CALCULATING THE STABILITY OF SLOPES OF EARTH DAMS IN CHECK CALCULATIONS OF SLOPES THAT FAILED,
N. A. Krasil'nikov.
Hydrotechnical Construction, Vol. 16, No. 10, p 560-567, October, 1982. 6 Fig, 5 Tab, 21 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 10, p 26-30, October, 1982.

Descriptors: *Earth dams, *Stability, *Mathematical studies, Dam construction, Dams, Slopes, Hydraulics, Soil properties, Computers.

To select the optimal method of calculating the stability of slopes of earth dams and to evaluate its accuracy, check calculations of the stability of more than 50 slopes that failed were performed. The calculations were performed on a computer simultaneously by several of the most used methods of calculation realizing the hypothesis of a circular-arc surface of sliding. These calculation methods are sufficient for conditions of earth dams. At present it is advisable to use the VNIIG-Terzaghi and Bishop methods in practical calculations of earth dams. Bishop's method, realizing Krey's model does not have any real advantages over the VNIIG-Terzaghi method. One of the slopes failed as a consequence of imperfection or inaccuracy of the calculation method. All failures of real slopes of structures occurred owing to the underestimation of the engineering-geological conditions of the foundation, insufficient consideration of the process of consolidation of the clay soil, or unfounded overestimation of the parameters of the shear strength of the foundation soil at the design stage. Therefore, the principal source for increasing the reliability of predictions of the stability of the slopes of earth dams lies in the timely refinement of the initial information. It is advisable to practice more widely the construction and investigation of experimental embankments in the preconstruction period. During further elaboration of problems of calculating the stability of earth dams it is advisable to use the achievements of the moden theory of landslide processes, bearing in mind that an earth dam works under specific conditions which are rarely found in nature. (Baker-IVI)
W84-01740

SOLAR RADIATION EFFECTS ON FROST ACTION IN SOILS,
C. W. Jones.
Transportation Research Record, Vol. 872, p 49-56, 1982. 12 Fig, 1 Tab, 6 Ref.

Descriptors: *Solar radiation, *Frost heaving, *Concrete technology, *Foundations, Canal linings, Soil temperature, Frost, Soil foundations, Canal drop structures, Coatings.

Engineers should be aware of solar radiation effects of frost action in soil foundations on the performance of surface structures. Damage to concrete canal drop structures and lining from frost heave on shaded sides in contrast to sun-exposed sides is described. To demonstrate passive solar effects on frost penetration, winter temperatures were measured on the concrete surfaces and in the soil subgrade beneath black-painted and unpainted concrete linings on shaded and sun-exposed sides of a small canal. Periodically, data on air temperatures, snow cover, and cloudiness were collected and incident radiation and radiation reflected from the different concrete surfaces were measured. Frost penetrated 37 % less on the painted, sun-exposed side than on the unpainted, sun-exposed side. Because of longwave, nighttime radiation, frost penetrated 28 % more on the painted shaded side than on the unpainted shaded side. For the unpainted concrete, frost penetrated 9-13 % less on sun-exposed than on shaded sides. (Author's abstract)
W84-01756

DESIGN OF CUT SLOPES IN OVERCONSOLIDATED CLAYS,
V. C. McGuffey.
Transportation Research Record, Vol. 873, p 8-11, 1982. 7 Fig, 4 Ref.

Descriptors: *Slope stability, *Seepage, *Groundwater level, *Clay, Slope degradation, Water table, Soil mechanics, Hydrodynamics, Stress release.

Long-term cut-slope stability is directly dependent of seepage force and, therefore, the ultimate groundwater level within the soils in the cut. The design of clay slopes for long-term stability was studied in relation to mode of failure, soil test methods, method of analysis, selection of parameters, and time dependency of stability. Long-term safety of overconsolidated clay slopes can be estimated by using the drained friction angle (plus a low residual cohesion) and seepage forces based on a high water table, determined by modified Bishop or a similar analysis. Stress release in overconsolidated clays is a time-dependent function, and an estimate can be made from the assumption of the simple hydrodynamic lag model and a depth of failure plane based on the geometry of the most critical section. (Moore-IVI)
W84-01758

8E. Rock Mechanics and Geology

FOUNDATION TREATMENT FOR INDIA'S SALAL DAM,
B. R. Chadha.
International Water Power and Dam Construction, Vol. 35, No. 8, p 53-56, August, 1983. 5 Fig.

Descriptors: *Dam construction, *Rockfill dams, Foundation rocks, Grouting, Permeability, India, Salal Dam, Water resources development, Leakage.

The Salal Dam is located in the northern loop of the Chenab river. The structure will be one of the highest rockfill structures in the country. It involves placement of 8,000,000 cu m of compacted materials, 96,000 m of grouting, and forms a major constituent of the Salal hydro project. The area of the right abutment consists of highly jointed dolomite with a number of shear zones and chart bands. The left abutment of the dam is guided by the bedding planes of the highly jointed dolomites which strike almost in a transverse direction to the axis and dip at 55 degrees northwards. A 50 mm-thick gunite has been applied to the full core base and on the downstream rock face of the core trench. In the reaches within the core trench where the permeability of the bedrock did not reduce to 10 Lugeons after consolidation grouting, a 6 m deep concrete cutoff has been provided with a 1 m base width and side slopes of 4 V to 1 H and a longitudinal slope of 1 V to 2 H. Grout intake in the shear zones is not excessive because of the presence of clayey material. High permeability values in the upper stages could be attributed to leakage through the weathered rock and the open-

ing out of joints to the surface. A drainage system has been provided on the downstream side of the core base in view of the shear zones running parallel to the river course and the difficulty in sealing them with cement grout. (Baker-IVI)
W84-01637

SCIENTIFIC BASIS OF THE DESIGNS OF THE UNDERGROUND STRUCTURES OF THE ROGUN HYDROELECTRIC STATION,
V. F. Ilyushin, V. M. Mostkov, and L. G. Osadchii.
Hydrotechnical Construction, Vol. 16, No. 12, p 637-643, December, 1982. 6 Fig, 5 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 12, p 34-38, December, 1982.

Descriptors: *Hydroelectric plants, *Construction, *Rock properties, *Stability, Geologic fractures, Dams, Powerplants, Dam construction, Tunnels, Penstocks, Rogun hydroelectric station, USSR.

The complex of underground structures of the Rogun hydroelectric station is unique not only in Soviet but also in foreign practice of underground hydrotechnical construction. In a geological respect the zone of the site represents a single tectonic block bounded by several faults. The seismicity of the zone of the hydrostation, and the entire region, is rated at intensity 9. The total length of the underground workings is more than 60 km. The development and scientific substantiation of a number of new, nontraditional designs both with respect to the design and layout of the structures and to the methods of constructing them were needed. A study of the stress state of the mass under the effect of longitudinal seismic waves directed along the route of the structures was carried out by investigating three dimensional models of a transparent optically inactive material with cemented-in Polaroids between which was a thin layer of optically sensitive material. Investigations of the structure in the stretch where the tailrace tunnels cross the channel of the Vakhsh River included a determination of the load on the pipes from the dam, which in this stretch rises to 250 m, and a determination of the forces in the structure from the assigned loads. The extent of the load on the structure in the river-crossing stretch was determined by the method of modeling with equivalent materials. In order to decrease the normal pressure of the soil several methods were proposed, the most expedient of which involved runoff in a defined sequence from a solid embankment above the construction part of the stretch. (Baker-IVI)
W84-01747

8F. Concrete

EXPERIENCE IN THE USE OF ROLLED CONCRETE,
Ministry of Construction, Tokyo (Japan). River Bureau.
T. Hirose.
International Water Power and Dam Construction, Vol. 35, No. 3, p 40-44, March, 1983. 5 Fig, 3 Tab, 5 Ref.

Descriptors: *Dam construction, *Rolled concrete, Design criteria, Engineering, Construction, Dams, Gravity dams, Japan.

The use of rolled concrete in dam construction has a number of advantages, some of which apply particularly to Japan where the river flows are heavy, and the transport of fill material would strain transport resources. The use of rolled concrete calls for a difference approach to dam construction. There is a way of determining the dam body cross section suitable for construction on relatively inferior and weak foundation ground of the kind often encountered. In contrast to the arch dam, the use of rolled concrete may be said to disperse stresses and make use of relatively weak bedrock. Rolled concrete is mainly placed in a horizontal plane as opposed to normal concrete which is applied at one point and therefore the selection of an appropriate equipment system is also important. The fundamental aim when using rolled concrete is to adopt the concept of the conventional concrete gravity dam through the design. Through practical application of rolled concrete in dam construction, many of the apparent problems have been solved. This method was suitable for current conditions in the construction of gravity dams. The ease of placment is greatly enhanced by the considerable reduction in contraction joints or construction joints, and work on the placement area is also carried out more safely. The method has been successfully applied to dams as well as to appurtenant structures. The most appropriate types of dam to make use of the rolled concrete method are likely to be those where the plan area of the dam body is wide in proportion to the height and where there are few structures inside the dam body. (Baker-IVI)
W84-01615

CONSTRUCTING THE DRAKENSBERG PRESSURE TUNNELS,
For primary bibliographic entry see Field 8A.
W84-01623

HYDROTECHNICAL CONCRETE OF THE UST-ILIM HYDROELECTRIC STATION,
M. A. Sadovich.
Hydrotechnical Construction, Vol. 16, No. 11, p 598-605, November, 1982. 1 Fig, 5 Tab, 13 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 11, p 19-23, November, 1982.

Descriptors: *Concrete, *Dam construction, Powerplants, Concrete construction, Concrete technology, Bratsk hydrostation, Ust-Ilim hydrostation.

The similarity of the climatic and engineering-geologic conditions of the construction of the Bratsk and Ust-Ilim hydroelectric stations and the participation of a common team of designers and builders in the construction led to a continuity of design, but considerable difference in hydrotechnical concrete used at both sites. A decrease of cement contents compared to analogous compositions of the Bratsk hydrostation, improvement of concrete quality, and increase in general technological discipline attest to definite progress in the technology of hydrotechnical concrete used at the Ust-Ilim hydrostation. Further progress was noted with the selection of a rational technology on the basis of experience at the Bratsk and Ust-Ilim stations, modernization of individual components, and the creation of a system of automatic compensation of the variability of the moisture content of aggregates at concrete plants, mechanization of concreting operations in the blocks, and increases of general efficiency. Site tests of the concrete of the Ust-Ilim dam showed that the solid concrete mass was particularly impermeable and the relatively small seepage flow occurred along the cracks and horizontal joints. One of the directions of the rational use of concrete can be a further reduction of the cement contents in concrete of the upstream column to an extent which does not cause damage when used as a material and will promote an increase of crack resistance of individual blocks and structures as a whole. Analysis of test results indicated that it was necessary to take into account the conditions of hardening of the concrete in the structure when assigning the concrete composition. In massive and underwater structures, concretes with low cement contents harden most intensely and for the longest time. The strength reserves occurring in this case remain unused. In outer surface zones, conversely, early drying and other unfavorable factors can lead to a decrease of the potential possibilities of concrete. (Baker-IVI)
W84-01742

STRUCTURE AND FROST RESISTANCE OF SAND CONCRETES WITH CHEMICAL ADDITIVES,
L. B. Gol'denberg, S. L. Oganeyants, and G. F. Voevoda.
Hydrotechnical Construction, Vol. 16, No. 11, p 606-608, November, 1982. 1 Fig, 3 Tab, 3 Ref. Translated from Gidrotekhnickeskoe Stroitel'stvo, No. 11, p 23-25, November, 1982.

Descriptors: *Concrete technology, *Concrete additives, *Freezing, Frost, Concrete, Dam construction, Construction materials, Cold regions.

The introduction of chemical additives, changing the initial water content of the concrete mix and kinetics of the structural formation of concrete, have an effect on its porosity and, consequently, on frost resistance. The structure and frost resistance of sand concretes were studied after the addition of the additives superplasticizers S-3 and NIL-20, the set-accelerator sodium sulfate, and combined additives composed of them. The introduction of plasticizing and combined additives causing a decrease of the initial water content of the cement sand mixtures from 210 to 180-185 l/cu m and an increase of the unit weight of concrete from 2315 to 2350-2360 kg/cu m leads to a decrease of the total volume of pores of the concrete from 16.2 to 12.9-13.2%. The addition of sodium sulfate did not have a substantial effect on the porosity. A reduction of the volume of open capillary porosity should lead to an increase of the frost resistance of concrete, which was demonstrated in further testing to be the case. The coefficient of frost resistance after 300 freeze-thaw cycles for concretes without an additive or with only an accelerator is 0.92-0.94 and for concretes with plasticizing and combined additives 1.00-1.20. The results obtained on analyzing the relation between frost resistance of concrete and its structure are comparable to the results obtained on the basis of direct tests. The introduction of chemical plasticizing and combined additives S-3, NIL-20, S-3+SS, NIL-20+SS, causing a decrease of the initial water content, leads to modification of the structure of concrete, decreasing the volume of open capillary pores, and increases the frost resistance of concrete. (Baker-IVI)
W84-01743

ON-SITE OBSERVATION OF THE CONCRETE STRUCTURES OF THE KAKHOVKA HYDROELECTRIC STATION,
S. Ya. Eidel'man.
Hydrotechnical Construction, Vol. 16, No. 12, p 657-663, December, 1982. 5 Fig, 4 Tab, 7 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 12, p 46-49, December, 1982.

Descriptors: *Concrete, *Hydroelectric plants, Construction, Failure, Stress, Dam construction, Dams, Kakhovka Hydroelectric Station.

The first unit of the Kakhovka hydroelectric station, whose total capacity is 321 MW, was started up 25 years ago. Settlements of the concrete structures of the hydrostation, which are diminishing, have been drawn out over more than 20 years. An increment of the settlement in recent years on some structures has ceased. The exception is one section of the downstream dolphin of the navigation lock located on an insufficiently compacted sand foundation bed. The greater part (80-90%) of the seepage head on the dam is lost on the blanket part of the underground contour, including the natural blanket of liman-marine silts. On the upstream sheet-pile wall 10-12% of the head is lost. The piezometric levels vary almost as a linear function of the fluctuations of the lower pool level. The character of the diagram of contact stresses in the bed soil, which is governed by the sequence of concreting the dam and increase of the upper pool level during filling of the reservoir, remained stable during the subsequent years of operation. A slight increase of contact stresses was noted at certain points of the bed under the indent of the dam. The stresses in the reinforcement of the massive foundation slabs are small. In the vertical reinforcement of the retaining walls the thermal stresses of the construction period reduced the tension on the back side and increase compression on the face side. Tensile stresses up to 140 MPa were measured in the reinforcement of the spiral casing after filling it with water. String-type sensors were installed in the concrete structures without the use of vulcanization of the joints of the cables. This and also the shortcoming of the design of the sensors resulted in their gradual failure. However, about 150 sensors that remained sealed have been operating for more than 25 years in the

concrete and saturated bed sands, and their readings are reliable. (Baker-IVI)
W84-01750

SOLAR RADIATION EFFECTS ON FROST ACTION IN SOILS,
For primary bibliographic entry see Field 8D.
W84-01756

8G. Materials

HIGH TENSILE STRENGTH STEEL FOR PENSTOCKS,
Wakayama Steel Works, Minato (Japan).
K. Maruyama.
International Water Power and Dam Construction, Vol. 35, No. 3, p 33-35, March, 1983. 5 Fig, 3 Tab.

Descriptors: *Steel, *Construction materials, *Penstocks, Dam construction, Dams, Japan, Bulgaria, Yugoslavia.

Large-scale dams and power stations, particularly pumped-storage plants, require penstocks of larger diameters and strengths to cope with the higher heads of water currently being exploited. The characteristics, of various types of high tensile strength steel manufactured in Japan for large scale penstocks are described. The use of HT (high tensile) steel plates means that the allowable stress can be higher, and the wall thickness of the penstock can be reduced compared with lower strength steel plates. The reduction in wall thickness results in direct and indirect cost reductions and lead to economics in the following areas: transport and installation as the weight is less; fabrication and welding which will be easier; and material savings as less will be required. Penstock pipes can be classified according to shape. HT steel plates are either used for part or all of the penstock, depending on the maximum hydraulic pressure on each part of the pipes. Fundamental requirements for penstock plate quality include: weldability - low preheating temperature and high maximum heat input; workability; fracture toughness; and inner quality. Examples of HT steel applications are found in Bajina Basta, Yugoslavia; Chaira, Bulgaria; and Imaichi, Japan. (Baker-IVI)
W84-01614

8H. Rapid Excavation

DIRECTIONAL BLASTING IN ROCKFILL DAM CONSTRUCTION,
Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Vodosnabzheniya, Kanalizatsii, Gidrotekhnicheskikh Sooruzhenii i Inzhenernoi Gidrogeologii, Moscow (USSR).
V. P. Nedriga, G. I. Pokrovsky, and N. P. Lushnov.
International Water Power and Dam Construction, Vol. 35, No. 6, p 37-40, June, 1983. 7 Fig, 1 Tab, 5 Ref.

Descriptors: *Excavation, *Dam construction, *Directional blasting, Reservoirs, Construction, Environmental effects, Economic factors, USSR.

Directional blasting is frequently used in dam construction in the mountainous regions of the USSR in order to shorten the construction time, reduce the labor content, provide considerable economies and help in the protection of soils in dams constructed by blasting operations. Those mountainous rivers favorably disposed to such treatment are characterized as follows: the gorge in the dam site is sufficiently narrow for the ratio of its width at the crest level to its height is not more than 2:3 with slopes of 30 degrees; the rock of the valley is suitable for placing in the dam body; the quantity of rock material which needs to be placed in the dam body must be somewhat higher than normal upper value with the optimum configuration within the construction site; and the sides of a valley must be easily cleared from humus, skeery and loose crumble. A homogeneous dam is a mass of rocks piled on the given site of a riverbed by directional blasting. Such dams usually have considerable permeability. A composite dam having face, or a face and a blanket is placed by both directional blasting in the downstream section and the usual operations used for transition zones, with faces of fine-grained and cohesive soils respectively. A hydroblasted dam consists of upstream and downstream sections placed by blasting, but the central core of impermeable soils is placed by hydraulic fill. Sometimes it is worthwhile constructing the antiseepage sections also with the help of directional blasting. The density of any coarse-grained material placed in a dam body depends on two factors: grain-size distribution of materials and methods of compaction. In this application the grain-size distribution of soils is characterized mainly by natural fissuration of the rock at the dam site, blasting operations and partly by the mechanical properties of the rock mass itself. The change in the grain-size because of falling after the explosion is insignificant and inherent in coarse rocks; in any case the amount is generally small. (Baker-IVI)
W84-01626

8I. Fisheries Engineering

MORTALITY OF JUVENILE SALMONIDS PASSING THROUGH OSSBERGER CROSS-FLOW TURBINES AT SMALL-SCALE HYDROELECTRIC SITES,
Cornell Univ., Ithaca, NY. Dept. of Natural Resources.
S. P. Gloss, and J. R. Wahl.
Transactions of the American Fisheries Society, Vol. 112, No. 2A, p 194-200, March, 1983. 4 Fig, 1 Tab, 10 Ref. 14-16-0009-80-1004.

Descriptors: *Turbines, *Mortality, *Salmon, *Trout, Fish migration, Fish size, Juvenile growth stages, Hydroelectric plants, Ossberger Crossflow turbine.

Experiments were conducted on Ossberger Crossflow turbines to determine the amount of mortality that would be incurred by downstream-migrating juvenile salmonids passing through these turbines. Species tested were Atlantic salmon Salmo salar, and rainbow trout and steelhead Salmo gairdneri. A highly significant ($P<0.01$) relationship between fish size and arc sine square root of mortality was found. Regression equations were calculated to predict expected mortality through 48 hours based upon size of fish. Mortality ranged from 15% for 85-mm fish to over 70% for 280-mm fish. No significant differences in mortality existed among similar size-groups of the three salmonids tested. Neither output of the turbine nor its size (650 versus 850 kilowatts) affected the amount of mortality. Temporal distribution of mortality after fish passed through the turbine was not different among species nor was it affected by the absolute rate of mortality in a given trial. Over 75% of the mortality was considered instantaneous. (Author's abstract)
W84-01402

LARVAL FISH TRANSPORT: A CASE STUDY OF WHITE BASS,
Tennessee Valley Authority, Knoxville. Div. of Water Resources.
L. B. Starnes, P. A. Hackney, and T. A. McDonough.
Transactions of the American Fisheries Society, Vol. 112, No. 3, p 390-397, May, 1983. 4 Fig, 1 Tab, 22 Ref.

Descriptors: *Larvae, *Fish behavior, Downstream transport, Velocity, Entrainment, Bass, Hydraulic transport, River flow.

Larval white bass Morone chrysops resisted downstream transport in the Holston River, eastern Tennessee. Despite a short hydraulic-transport time (<20 hours) through the study area (19.8 km), larvae were not transported downstream and out of this region soon after hatching. Recently hatched larvae were collected near a dam that blocks migration of spawning adults at the upper end of the study area; however, downstream from the dam larvae were significantly larger (and older) than expected if they had been transported passively through the area. Larval white bass probably remain near bottom or in other low-velocity refugia that effectively reduce downstream displacement. Hybrid striped bass Morone saxatilis x white bass larvae 4 mm and longer oriented upstream in a laboratory flume; they swam vigorously and utilized areas of low current velocity to reduce downstream displacement. Retarded downstream transport found in the riverine environment, coupled with laboratory observations, implies that improvements are needed in models used to estimate entrainment of fish larvae. (Author's abstract)
W84-01415

MULTIPLE REGRESSION ANALYSIS FOR FORECASTING CRITICAL FISH INFLUXES AT POWER STATION INTAKES,
Central Electricity Generating Board, Fawley (England).
A. W. H. Turnpenny.
Journal of Applied Ecology, Vol. 20, No. 1, p 33-42, April, 1983. 4 Fig, 3 Tab, 12 Ref.

Descriptors: *Fish populations, *Entrainment, *Powerplants, Cooling water, Regression anaylsis, Statistical models, Fish impingement, Water temperature, Tides, Wind speed.

Certain coastal power stations in Britain are subject to ingresses of fish which may jeopardize plant operation or which may cause temporary local depletion of fish populations. There have been attempts in the United States and in Europe to develop costly and often ineffectual exclusion devices. As an alternative, it is proposed that, for sites where the problem is intermittent, statistical models should be developed which allow critical levels of fish ingress to be predicted and the necessary reduction in cooling water flow determined. The procedure for developing a multiple regression model is described and illustrated using fish impingement data collected from Fawley Power Station. Over 60% of the overall variation was accounted for in terms of a small number of easily measured variables (cooling water flow, water temperature, tide height, wind speed). In other research work, values of up to 80% have been quoted. With refinements of the model formulation higher values should be possible and the approach then would have practical application. (Author's abstract)
W84-01440

RESTORATION OF A DISUSED DOCK BASIN AS A HABITAT FOR MARINE BENTHOS AND FISH,
Liverpool Univ. (England). Hartley Botanical Labs.
G. Russell, S. J. Hawkins, L. C. Evans, H. D. Jones, and G. D. Holmes.
Journal of Applied Ecology, Vol. 20, No. 1, p 43-58, April, 1983. 9 Fig, 1 Tab, 20 Ref.

Descriptors: *Estuarine environment, *Marine fish, *Marine plants, Water quality, Habitats, Destratification, Salinity, Water temperature, Oxygenation, Trace metals, Mytilus, Artificial habitats.

Changes in the water quality, and in flora and fauna, of a Liverpool dock have been monitored since closure of its gates in 1977. Water salinities have been found to fall within the range 25-31%, and temperatures 0.3-19 degrees C. Secchi disc extinction depths averaged 5-6 m in the dock and 10 cm in the Mersey estuary outside. An air-lift pump has been installed which prevents stratification during summer and ensures an oxygen-rich water column. The absence of harmful dinoflagellate blooms is attributed to artifical destratification by this method. Improvements in water quality have been accompanied by the development of a more diverse marine flora and fauna than in other unclosed docks. The benthic community is dominated by Mytilus edulis. Trace metal concentrations and coliform bacterial counts in Mytilus flesh are sufficiently low for the animals to comply with existing food safety regulations. Introduced Laminaria saccharina grew until water temperatures reached 15 degrees C, but a few plants survived a

14-week period in summer 1981 when ambient water temperatures were above 15 degrees C. It is concluded that a dock of this character can be maintained as a productive marine environment with a variety of educational, amenity and economic uses. (Author's abstract)
W84-01441

DESIGN OF HABITAT STRUCTURES FOR OPEN CHANNELS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
F. D. Shields, Jr.
Journal of Water Resources Planning and Management, Vol. 109, No. 4, p 331-344, October, 1983. 1 Fig, 4 Tab, 32 Ref.

Descriptors: *Habitat structures, Aquatic habitats, Sills, Current deflectors, Boulders, Channel modification, Channeling, Stream biota.

In many cases, channel modifications have extremely adverse impacts on aquatic communities. Rudimentary design guidelines are presented for simple structures (sills, current deflectors, and individual boulders) used to accelerate biological recovery of modified stream channels. These structures increase the physical habitat diversity of a modified channel. Data from nine case studies are presented in tabular form, including stream channel characteristics, structure dimensions, and an analysis of biological effectiveness and structural durability. Available literature on habitat structures focuses on applications to unenlarged coldwater streams with coarse bed material. Documented experience with enlarged warmwater streams that have poorly armored channels is extremely limited. (Author's abstract)
W84-01469

FINDING SALMON AND TROUT IN LAKE ONTARIO,
State Univ. of New York Coll. at Brockport.
J. M. Haynes.
Water Spectrum, Vol. 15, No. 1, p 30-37, Spring, 1983. 11 Fig.

Descriptors: *Fishing, *Lakes, *Telemetry, Data collecting, Fish, Population dynamics, Trout, Salmon, Lake fisheries, Water temperature.

Radiotelemetry and vertical gill netting were used to obtain knowledge about the whereabouts of some species of fish during certain seasons of the year in Lake Ontario. Particular attention was given to the chinook salmon. Salmon and trout move great distances during seasons when they are nearshore. Summer netting revealed that steelhead/rainbow trout and Pacific salmon are widely dispersed and far offshore, while lake and brown trout are concentrated in narrow temperature preference bands associated with the thermocline, lake bottom, and nearshore regions. It is felt that such studies will bring new research approaches to solve problems for the Great Lakes fishing industry and help in restoring economic and ecological health to the region. (Baker-IVI)
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